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The key role of forest and landscape restoration in climate action

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The key role of forest and landscape restoration in climate action

by
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Food and Agriculture Organization of the United Nations
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Abbreviations and acronyms

ADB	Asian Development Bank
AF	Adaptation Fund
AFOLU	agriculture, forestry and other land use
ANR	assisted natural regeneration
ART	Architecture for REDD+ Transactions
CBD	United Nations Convention on Biological Diversity
CH_4	methane
CO_2	carbon dioxide
COP	Convention of the Parties
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CPF	Collaborative Partnerships on Forests
DFID	UK Department for International Development[1]
FAO	Food and Agriculture Organization of the United Nations
FFEM	French Facility for Global Environment
FFF	Forest and Farm Facility
FLR	forest and landscape restoration
GBEP	Global Bioenergy Partnership
GCF	Green Climate Fund
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas
GPI	Global Peatlands Initiative
GPFLR	Global Partnership on Forest Landscape Restoration
GSOC	Global Soil Organic Carbon Map
IFAD	International Fund for Agricultural Development
IFI	international financial institution
IIED	International Institute for Environment and Development
IKI	International Climate Initiative
IPCC	Intergovernmental Panel on Climate Change
IRP	International Resource Panel
ITTO	International Tropical Timber Organization
IUCN	International Union for Conservation of Nature
IUCN CEM	IUCN Commission on Ecosystem Management
IUFRO	International Union of Forest Research Organizations

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[1] From June 2020, merged into Foreign, Commonwealth and Development Office (FCDO).

LDN	land degradation neutrality
LEAF	Lowering Emissions by Accelerating Forest finance
MSA	mean species abundance
N_2O	nitrous oxide
NDC	nationally determined contribution
NAP	national adaptation plan
NAPA	national adaptation programme of action
NTFP	non-timber forest product
NYDF	New York Declaration on Forests
PES	payments for ecosystem services
REDD+	Reducing Emissions from Deforestation and Forest Degradation, plus the sustainable management of forests and the conservation and enhancement of forest carbon stocks
SDG	Sustainable Development Goal
SEPAL	System for Earth Observation Data Access, Processing and Analysis for Land Monitoring
SER	Society for Ecological Restoration
SFM	sustainable forest management
SIDS	small island developing state
STAP	Scientific and Technical Advisory Panel
TREES	The REDD+ Environmental Excellence Standard
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WMO	World Meteorological Organization
WRI	World Resources Institute

Executive summary

Forest and land degradation affects almost 2 billion hectares (ha) of land and threatens the livelihoods, well-being, food, water and energy security of nearly 3.2 billion people. Forest and landscape restoration (FLR) is a relatively recent response to address these impacts and aims to recover the ecological functionality and enhance human well-being in deforested and degraded landscapes. Forest and landscape restoration practices have also proven to have significant benefits for addressing the impacts of climate change. These include carbon sequestration and reduction of greenhouse gas (GHG) emissions, improving the resilience of landscapes and reducing disaster risks. Forest and landscape restoration is therefore one of the key solutions of the agriculture, forestry and other land-use (AFOLU) sector considered in the United Nations Framework Convention on Climate Change (UNFCCC), confirmed in the Glasgow's Declaration on Forest and Land during the twenty-sixth Conference of the Parties to the UNFCCC (COP26).

This publication highlights the links between FLR and climate change mitigation and adaptation issues, and considers further opportunities to enable greater integration between the two agendas. Many large restoration initiatives have been launched in the last decade. More projects are under preparation through the United Nations Decade on Ecosystem Restoration, including many projects of the Food and Agriculture Organization of the United Nations (FAO). These projects, often funded under the Global Environment Facility (GEF) and other climate funds are emphasized in the report to illustrate the numerous climate benefits of FLR.

As a relatively cost-effective approach to supporting carbon sequestration, conservation and sustainable forest use, FLR is playing an active role in enabling climate mitigation. Should the Bonn Challenge reach its goal to restore 350 million ha, it could sequester up to 1.7 gigatonnes of carbon dioxide (Gt CO_2) per year. Reduction of GHG emissions is also crucial, and the FLR approach provides a strong basis to reduce emissions from deforestation and forest degradation, especially through Reducing Emissions from Deforestation and Forest Degradation (REDD+) activities. It can also support sustainable bioenergy, in particular the wood energy sector, a large contributor of GHGs. Forest and landscape restoration is also key for supporting the conservation of existing forests and landscapes to protect and enhance carbon already stored in ecosystems, such as those in peatlands. This publication describes the different tools that have been developed by FAO to better measure the quantities of carbon stored and other climate benefits achieved through FLR projects.

The paper also highlights the significant role of FLR in climate adaptation. Restoration of forests and landscapes improves the ecological functionality and provision of ecosystem services within landscapes, reducing the impact of climate change. It also decreases the vulnerability and increases the resilience of forests and forest-dependent communities to climate change. From agroforestry to assisted natural regeneration (ANR), FLR offers a large range of interventions, which are growing in scale and often included in national adaptation plans (NAPs) and nationally determined contributions (NDCs) of the Paris Agreement. These interventions also have extensive potential to support wider development benefits and the achievement of numerous Sustainable Development Goals (SDGs).

This paper describes the conditions for success of FAO's FLR projects for both restoration and climate change mitigation and adaptation outcomes. It also proposes pathways to identifying funding opportunities linked to the climate agenda to boost restoration efforts, better promote FLR in the NDCs and incorporate climate mitigation and adaptation objectives in wider FLR initiatives, including the United Nations Decade on Ecosystem Restoration 2021–2030.

Phnom Dek, Preah Vihear, Cambodia - A forest community member shows a young bamboo plant which has been planted as part of the restoration efforts in his forest community

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1. Introduction

The recent Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6)[2] (IPCC, 2021, 2022a, 2022b) has found unequivocally that human influence has caused significant rises in global temperatures and rapid changes in the atmosphere, ocean, cryosphere and biosphere, and caused extreme weather events. Greenhouse gases (GHGs), including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), have all increased at rates higher than at any time in at least 800 000 years, with CO_2 concentrations at their highest level in the past 2 million years. There is a risk that the remaining global carbon budget will be exhausted in the coming decade. Unless deep emissions reductions occur, globally agreed climate targets of 1.5 °C and 2 °C warming will be exceeded during the twenty-first century (IPCC, 2021, 2022a, 2022b). Despite years of efforts to reduce GHG emissions from agriculture, forestry and other land use (AFOLU), it is clear that progress has been limited.

Urgent action is therefore needed to mitigate and adapt to the increasing risks of climate change (IPCC, 2022a, 2022b). Attempts to accelerate climate action are being implemented through numerous land-related responses that address land degradation, combat desertification and enhance food and livelihood security (IPCC, 2019). Context-specific responses such as halting deforestation, soil organic carbon management, ecosystem conservation, enhancing sustainable production and use, reduced degradation and building carbon sinks through the restoration of forests and landscapes can also increase community and ecosystem resilience to climate change impacts.

Globally, forest and land degradation have significant negative ecological and social impacts affecting approximately 3.2 billion people and 2 billion hectares (ha) of land (GEF, 2021a; Olsson *et al.*, 2019). Land degradation from the combined impacts of climate, physical processes and unsustainable land-use practices can have direct and indirect effects on landscapes (Figure 1). Physical effects include an overall decline in vegetation and biomass, increasing heat stress and local climate regulation; and increases in soil erosion, reducing nutrient loss and soil moisture and salinization (IPCC, 2019). These changes accelerate global climate change, increase biodiversity loss and can induce poverty, migration and conflicts. This reduces ecosystem resilience and the adaptive capacity of resources users (Webb *et al.*, 2017).

Forest degradation, caused by unsustainable timber and fuelwood harvest practices, and the incidence of wildfires and pests and disease, reduces the ability of forests to sequester and store carbon and provide other essential ecosystem services (Figure *1*). Studies estimate annual forest degradation emissions of 2.1 billion tonnes (t) of CO_2 across 74 developing countries, higher than their emissions from deforestation alone (Pearson

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[2] More information on the contributions of the different Working Groups and parts of AR6 can be found here: www.ipcc.ch/assessment-report/ar6/

Illegal logging and deforestation, Malawi

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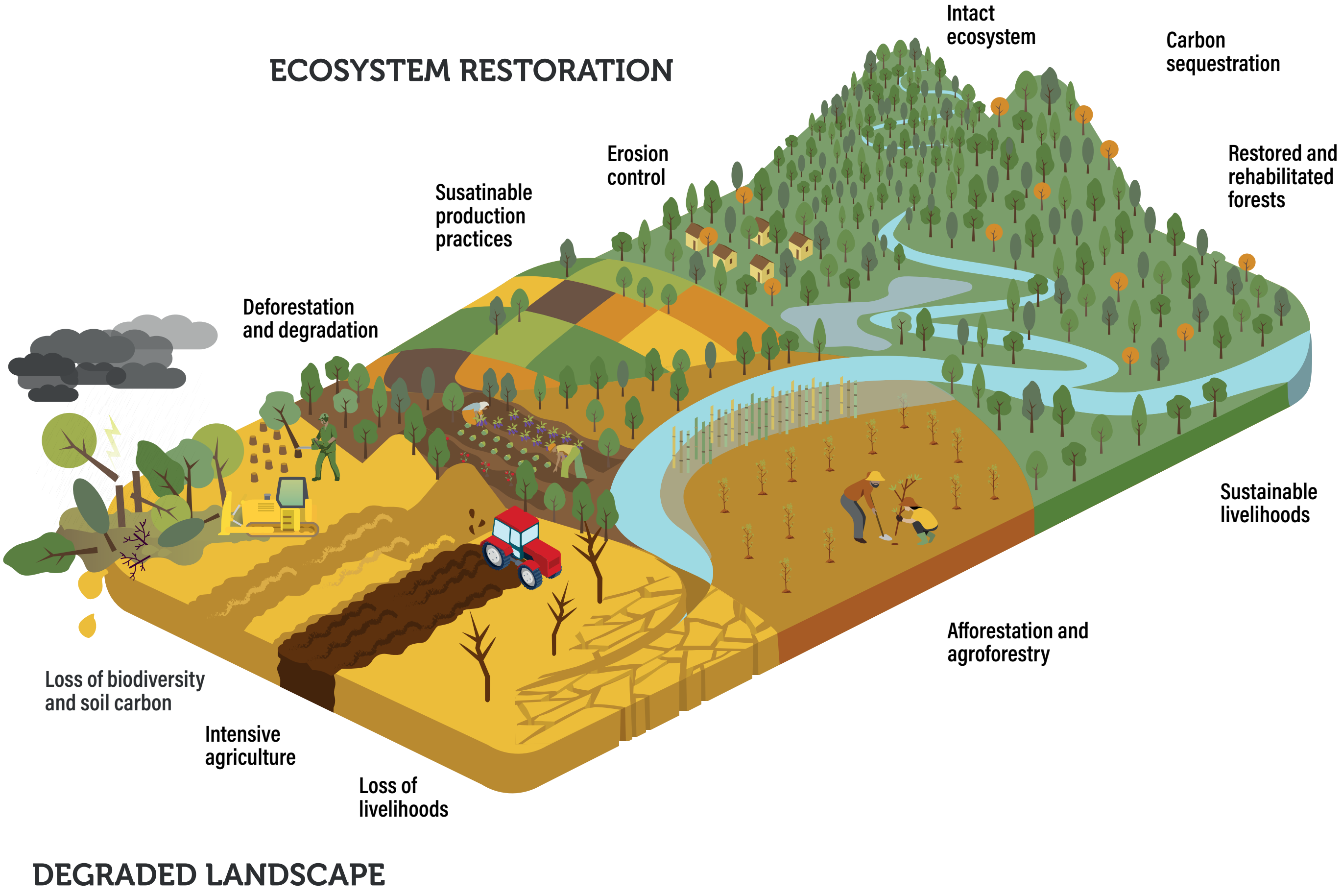
et al., 2017). The biophysical effects of changes in forest structure, cover and composition also create significant shifts in water and energy balances, impacting biophysical processes (Lawrence *et al.*, 2022). Forests not only have a role in cooling local climate, but also help mitigate the impacts of extremes of heat, floods and droughts caused by climate breakdown. Shifts in the biophysical qualities of forests may amplify the effects of carbon emissions, and their ability to help stabilize local climate temperatures.

The pivotal role of forests in the climate change agenda is recognized in many United Nations climate change and biodiversity conservation agreements. Some of these, such as Goal 7 of the New York Declaration on Forests (NYDF), "Taking stock of national climate action for forests", have been achieved with the Paris Agreement's "confirmation of forests' pivotal role in the international climate agenda" (NDYF Assessment Partners, 2021). Many national determined contributions (NDCs) also recognize these benefits, with 79 percent of new and updated NDCs referencing the role of forest systems for mitigation, and 68 recognizing the role of trees in adaptation (as of 31 July 2021). However, despite many commitments to slow deforestation (e.g. NYDF 2014 aimed to halve deforestation by 2020), increases in forest (and forest carbon) loss and degradation from forest conversion have continued. This includes deforestation from cattle farming, large-scale agricultural production (palm oil plantations, cacao, rubber and coffee, etc.) and those causes often not included in IPCC reports, such as small-scale deforestation and mountain area land clearance (Feng *et al.*, 2022).

Figure 1
How FLR can support climate change mitigation and adaptation at landscape level

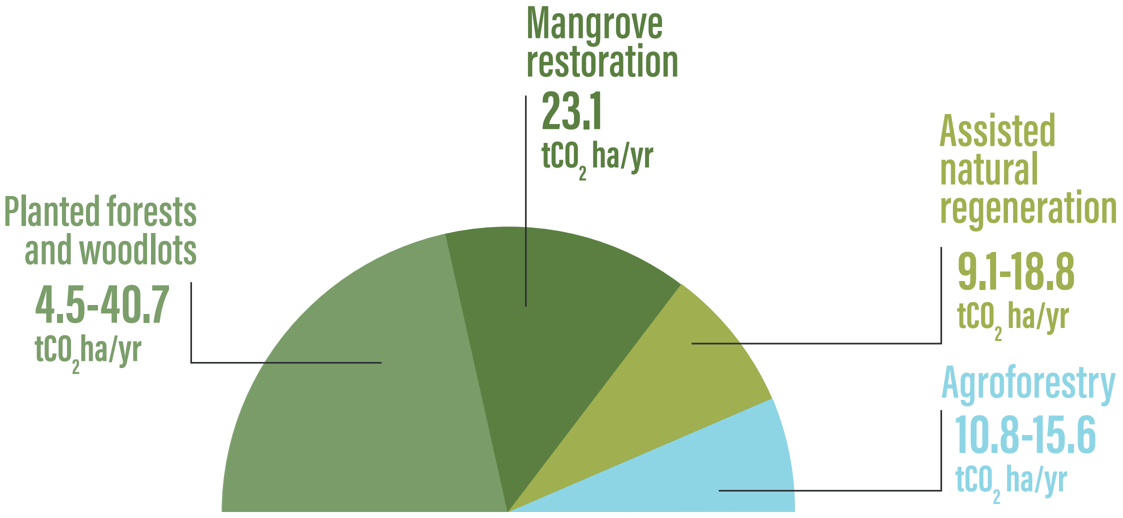

ECOSYSTEM RESTORATION
Intact ecosystem
Carbon sequestration
Erosion control
Restored and rehabilitated forests
Susatinable production practices
Deforestation and degradation
Sustainable livelihoods
Afforestation and agroforestry
Loss of biodiversity and soil carbon
Intensive agriculture
Loss of livelihoods
DEGRADED LANDSCAPE

Addressing these various and interrelated challenges is often the principal motivation for many restoration interventions, such as the FLR approach. Forest and landscape restoration is a natural climate pathway with one of the highest mitigation potentials. Restoration through afforestation and reforestation could cost-effectively remove 0.9–1.5 gigatonnes of carbon dioxide equivalent (GtCO$_2$eq) per year from the atmosphere between 2020 and 2050 (FAO, 2022). Restoration of forests and tree cover also offers essential "adaptation services", increasing rainfall during times of drought, reducing the effects of heat, providing habitat for biodiversity and creating jobs for local people. Restoration of coastal wetlands can also protect communities from storm surge and erosion. Forest and landscape restoration can therefore strengthen the ecological integrity of landscapes and support the development of sustainable and new livelihoods for local populations. It has further benefits, including the protection of vital ecosystem services, such as the quantity and quality of water supplies, enrichment of biodiversity and soil fertility, the production of timber and non-timber forest products (NTFPs), and aesthetic and cultural values (Christin, Bagstad and Verdone, 2016).

Different restoration activities through FLR can enable varying climate change adaptation and mitigation benefits dependent on the landscape's biophysical characteristics, local climate, species used, management practices and restoration approaches. A Global CO_2 Removals Database (Winrock International and IUCN, 2018) developed by Bernal *et al.* (2018) has identified the extent to which biomass accumulation rates from natural regeneration, planted forests and woodlots, agroforestry and mangrove restoration capture CO_2. Annual CO_2 removal rates were found to be highest in planted forests and woodlots (4.5–40.7 t CO_2 per ha), followed by mangrove restoration (up to 23.1 t CO_2 per ha), natural regeneration (9.1–18.8 t CO_2 per ha) and agroforestry (10.8–15.6 t CO_2 per ha) (Figure 2). This highlights the significant potential for FLR activities to mitigate climate change impacts and can inform the targeted restoration of ecosystems with high climate mitigation and adaptation potential. For example, peatland and mangrove ecosystems support both mitigation and adaptation capacity. While increasing biomass accumulation above and below ground, peatland rewetting protects coast and river habitats from subsidence. Both peatland and restored mangrove habitats also protect coastal areas from climate change-induced storms and the aggravated impacts of sea level rises.

Figure 2

Climate change mitigation potential from FLR interventions: carbon removal rates



To achieve the 1.5 °C and 2 °C temperature targets of the Paris Agreement, emissions of GHGs not only need to be significantly reduced, but removals of GHGs from the atmosphere also need to be increased (Busch *et al.*, 2019). This presents a clear opportunity for FLR to benefit climate change adaptation and mitigation outcomes. Many challenges, however, prevent the proper portrayal of the benefits of FLR for mitigating and adapting to climate change, and therefore limit its scaling-up. These include, for example, the estimated impact on the GHG balance (Bernal ***et al.***, 2018) which is often overlooked within the long-term monitoring requirements of FLR programmes. Where forest carbon is monitored, the diversity of monitoring systems creates further difficulties to consistently evaluate mitigation potential across scales (Harris ***et al.***, 2021).

The effects of climate change are already being felt across the globe, illustrated by observed weather and climate extremes. The recent IPCC AR6 (IPCC, 2021, 2022a, 2022b) emphasizes the critical importance of these carbon sinks to support the best-case climate scenario of +1.5 °C. It also highlighted that reducing and halting deforestation, the restoration of forests and landscapes and sustainable management practices can support the protection and building of these carbon sinks, while concurrently enhancing ecosystem and human adaptive capacity and resilience to climate change.

The cost-effectiveness of different restoration initiatives for climate change mitigation and adaptation outcomes is also unclear. For example, Busch ***et al.*** (2019) have estimated that CO_2 removals from tropical reforestation could increase by 5.7 gigatonnes (Gt) of CO_2 (56 percent) with carbon prices of USD 20 per t CO_2 or 15.1 Gt CO_2 (14.8 percent) at USD 50 per t CO_2. While FLR activities such as avoided deforestation and reforestation may enable large-scale CO_2 removal and storage in above- and below-ground biomass, the estimated cost per tonne for different ecosystems remains highly variable and therefore uncertain (Busch ***et al.***, 2019). Beyond carbon storage, benefits of restoration, such as biophysical impacts on ecosystem function and provision, sustainable livelihoods, diversified food and non-food products, improved flood and erosion control, and better climate regulation, can also be overlooked. Intact and restored forests have significant economic climate value, illustrated by their resilience and adaptive capacity to threats and shocks for both the ecosystems and communities of those dependent on them (UNEP, 2021a).

Knowledge and best practices for the implementation of FLR on the ground have been developed from lessoned learned from many FLR projects, developed by the Food and Agriculture Organization of the United Nations (FAO) and its partners (FAO, 2015, 2020a). For example, successful restoration often resulted where flexible and adaptive government institutions were able to adapt to local stakeholders' needs. Integration and coordination with other sectors and ministries (e.g. agriculture, energy, transportation, finance and urban development) was also identified as important to minimize and mitigate negative impacts on forests and landscapes. This can also support the communication of the value of forests and landscapes to provide a diversity of ecosystem services to other sectors (Appanah ***et al.***, 2015). Tools, data and methodologies to estimate the ecological, socioeconomic and disaster risk reduction contribution of land use, land-use change and forestry to address climate change-specific issues are also available. These can be used to illustrate the role of restorative approaches in contributing to climate change agendas. Further research about FLR's contribution to the capacity to mitigate and adapt to climate change is however required.

The United Nations Decade on Ecosystem Restoration, co-led by FAO and the United Nations Environment Programme (UNEP), started in June 2021 and provides an important opportunity to better link and promote restoration to the climate agenda of 2021 (Bastin *et al.*, 2019; Mansourian *et al.*, 2017), and support the wider *build back better* objective post COVID-19 pandemic and green recovery activities. Many new projects are under preparation thanks to the United Nations Decade, such as the Leaders' Pledge for Nature, the High Ambition Coalition for Nature, and many associated pledges. It is imperative that information on the impacts of and potential synergies between restoration and the mitigation of and adaptation to climate change is collected and synthesized from these developments and initiatives. The role of FLR in cost-effective and equitable climate action needs to be properly established.

Along with restoring forests and landscapes, this report also highlights the urgent need to protect carbon sinks through halting deforestation and promoting sustainable forest management (SFM) practices. These actions will simultaneously enhance the adaptive capacity and resilience of people and ecosystems. The paper illustrates the actual and potential role of FLR interventions in the climate change adaptation and mitigation agendas. Through an analysis of FLR flagship projects and literature, it highlights the criteria that can be used to support the integration of restoration and climate change outcomes. It also examines the strategies used to integrate the FLR process approach into climate change mitigation and adaptation projects and programmes, and also identifies opportunities to enhance investment for FLR, climate action and sustainable management or development (Sustainable Development Goals [SDGs]). It proposes recommendations for enabling greater synergies between the implementation of FLR and climate change mitigation and adaptation programmes and activities to generate greater cobenefits that support resilient restoration outcomes.

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View of the native forest deep in the Obô Natural Park in São Tomé and Príncipe

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2. Forest and landscape restoration and the current global climate change agenda

Deforestation and land degradation have significant impacts worldwide, threatening the livelihoods, well-being, food, water and energy security and resilience of millions of people (Sabogal *et al.*, 2015). The notion of FLR was developed in the first decade of the twenty-first century (Reitbergen-McCraken, Maginnis and Sarre, 2007) and describes an integrated approach that applies participatory decision-making processes and involves all stakeholders in all affected land-use sectors. As stated on the Global Partnership on Forest and Landscape Restoration (GPFLR) website:

FLR is defined as a process that aims to regain ecological functionality and enhance human well-being in deforested and degraded landscapes. It is not an end in itself but a means to regaining, improving and maintaining vital ecological and social functions, in the long-term leading to more resilience and sustainable landscapes (GPFLR, 2018).

Restoration is complex and requires a diverse array of tools and solutions, and an adaptive approach to meet ever-changing local needs and national-level priorities. Forest and landscape restoration activities are therefore implemented by a diverse set of actors on the ground; from smallholders planting trees on their farms and improving their agroforestry and agricultural practices, to those driving larger-scale restorative practices at a landscape scale. It can enable a focus on the engagement of Indigenous Peoples in decision-making processes and adaptive management of natural resources, especially when land tenure is insecure. This provides a strong link between FLR activities and delivery of diverse socioeconomic benefits for those implementing restoration and those “downstream” benefiting from improved provision of ecosystem services.

The diverse nature of the FLR process and approach not only focuses on the restoration of degraded land but also on the maintenance and sustainable use of existing standing forest and other healthy landscapes to ensure ecosystem functionality rather than just maximizing forest cover. These dynamic objectives aim to strengthen landscape

Aerial view of cashew nut plantation encroaching on forest land, Phnom Dek, Preah Vihear Province, Cambodia

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resilience and optimize ecosystem goods and services according to societal needs or as new challenges arise, increasing the productivity of landscapes, enhancing forest ecosystem resilience, and reducing the vulnerability of forest-dependent communities (Stanturf *et al.*, 2015).

As the second largest source of GHG emissions, accounting for 23 percent of total net global anthropogenic GHGs, the AFOLU sector is uniquely placed to deliver on both mitigation and adaptation objectives. In particular, FLR measures are considered as one of the potential solutions in this sector since they often combine mitigation and adaptation approaches (IPCC, 2022a, 2022b). By enhancing landscapes to ensure long lasting benefits that include job development and economic growth, poverty alleviation, improved governance, food security, ecosystem resilience, biodiversity conservation and carbon capture, FLR contributes to immediate and long-term climate change mitigation and adaptation outcomes (Stanturf *et al.*, 2015) (Figure 3). Greenhouse gases are absorbed by healthy forests and ecosystems, locking in carbon and increasing resilience to climate change impacts for the landscape and communities living in and around it (Shukla *et al.*, 2019).

Intact and restored forest ecosystems have the potential to remove approximately 12 billion t CO_2 from the atmosphere (IPCC, 2019). Annually, this has the potential to counteract almost 30 percent of human GHG emissions to meet the goals of the Paris Agreement.[3] Ecosystems with a significant short- and long-term carbon sink function (i.e. "irrecoverable carbon"), such as old-growth forests, mangroves and peatlands, should be prioritized for protection and conservation to remain intact. At the same time, FLR measures such as afforestation and reforestation can contribute further

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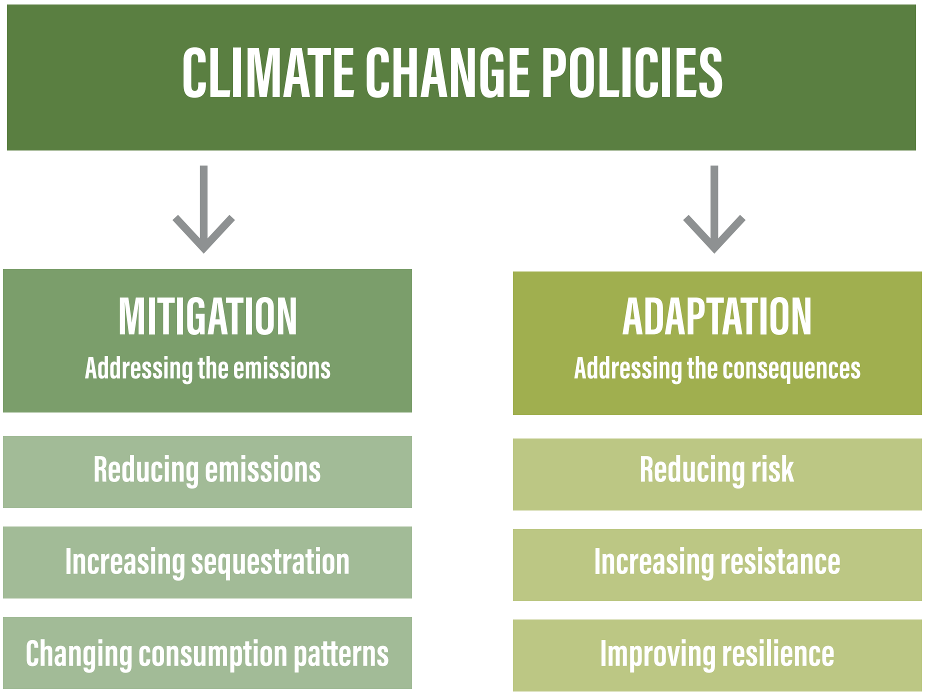
[3] See www.oneplanetsummit.fr/en/coalitions-82/coalition-convergence-climate-and-biodiversity-finance-191

Figure 3
How FLR contributes to strategies to address climate change impacts


CLIMATE CHANGE POLICIES
MITIGATION
Addressing the emissions
Reducing emissions
Increasing sequestration
Changing consumption patterns
ADAPTATION
Addressing the consequences
Reducing risk
Increasing resistance
Improving resilience

Source: FAO & Global Mechanism of the UNCCD (United Nations Convention to Combat Desertification). 2015. Sustainable Financing for Forest and Landscape Restoration – Opportunities, challenges and the way forward. Discussion Paper. Rome.

by enhancing carbon sequestration and building additional long-term carbon sinks to support "negative emissions" (IPCC, 2019). It is estimated that woodland and forest restoration would reduce a considerable proportion of the global anthropogenic carbon burden (approximately 300 Gt of carbon) and it is one of the most effective strategies for climate change to limit the rise of CO_2 concentrations across the globe (Bastin *et al.*, 2019).

2.1. Indigenous Peoples

Communities in forest landscapes, in particular Indigenous Peoples, are considered to be among the groups most vulnerable to climate variability and change as they depend on climate-sensitive activities for their sustenance and livelihoods (IPCC, 2019). The pivotal role of Indigenous Peoples in protecting global forests and lands, and therefore regional and global climate stability has been widely recognized (IPCC, 2019; IPBES, 2019; Rainforest Foundation Norway, 2021; FAO and FILAC, 2021).

Analysis by the Rights and Resources Initiative (RRI) (2018) estimates that at least 17 percent (293 000 million t CO_2) of total carbon stored in forests is managed by Indigenous

Peoples. Lower deforestation rates have been demonstrated in land managed by communities with legal recognition of their tenure rights. These lands, compared to those not under community management, will therefore have lower carbon emissions (Rainforest Foundation Norway, 2021). For example, in the Amazon basin, legally recognized Indigenous Peoples' territories lost less than 0.1 percent of the carbon in their forests between 2003 and 2016. Protected areas lost six times more of their carbon stock (Rainforest Foundation Norway, 2021).

Threats to Indigenous Peoples' territories are now increasing following external pressures on their land. Government policies that recognize and secure local community and Indigenous Peoples' land rights, enhance and support their participation in forest and land management, and reduce external threats to their natural resources are therefore crucial (Rainforest Foundation Norway, 2021; IPBES, 2019; FAO and FILAC, 2021). Twenty-four countries have made commitments to strengthen or expand land tenure of Indigenous Peoples in their NDCs. Despite this, only a small fraction have secure and legally recognized land tenure.

Local communities are also inadequately represented in international funding processes, such as the Green Climate Fund (GCF), the Global Environment Facility (GEF) and bilateral aid, to support climate change mitigation and adaptation (MacQueen, 2021). With approximately USD 70 billion of international climate finance mobilized annually since 2017, only 10 percent is believed to have reached the local level, of which 1.7 percent reached forest smallholders and their organizations (MacQueen, 2021). The twenty-sixth Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) has made steps to recognize their key role in protecting tropical forests and preserving ecosystems, pledging USD 1.7 billion directly to Indigenous Peoples through the COP26 IPLC Forest Tenure Joint Donor Statement.[4] This finance aims to enable greater recognition of Indigenous Peoples' forest tenure rights and rewards for their role as guardians of natural resources.

It is essential to engage and partner with Indigenous Peoples to take climate and restoration action (Rainforest Foundation Norway, 2021). Restoration interventions supporting strong tenure rights and integrating Indigenous Peoples to play a key role in customary institutions and co-management approaches that protect, restore and sustainably manage forests and forested landscapes, can be an effective way of protecting carbon stores, safeguarding biodiversity and incorporating their extensive knowledge of local ecosystems. Forest and landscape restoration is a participatory approach in decision-making and implementation for restoration. Full equitable engagement of Indigenous Peoples is crucial throughout this process to tailor solutions to local environmental, socioeconomic and political contexts. This can support adaptive management to modify interventions and enhance the resilience of Indigenous Peoples against the impacts of climate change (Seddon *et al.*, 2021).

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[4] See https://ukcop26.org/cop26-iplc-forest-tenure-joint-donor-statement

The Banaue Rice Terraces in the Philippines. Integrated Pest Management (IPM) is a technique by which farmers encourage the natural enemies of the pests attacking their crops. These enemies, such as wasps and spiders, then help eliminate the pests, reducing the need for pesticides.

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2.2. Forest and landscape restoration in international pledges and initiatives

The restoration of deforested and degraded forest lands have been included in numerous United Nations climate change and biodiversity agreements in their decisions, highlighting their recognition of the importance of FLR to contribute to diverse outcomes (Table 1). For example, the United Nations Convention on Biological Diversity (CBD) Aichi Target 15[5] which calls for ecosystem resilience and the contribution of biodiversity to carbon stocks to be enhanced through conservation and restoration, including restoration of at least 15 percent of degraded ecosystems. Currently, over 2 billion ha of restoration commitments have been made, with the potential for significant impacts on gross domestic product (GDP) (Griscom ***et al.***, 2017). These ambitious national and international pledges and targets to restore degraded and deforested landscapes have highlighted the potential of the FLR approach to contribute to resolving the most pressing environmental challenges, including combating climate change (Fagan ***et al.***, 2020). At the global scale, these include the Bonn Challenge[6] (which aims to restore 350 million ha of degraded and deforested landscapes by 2030), the Paris Agreement, the United Nations Convention to Combat Desertification (UNCCD) land

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[5] See www.cbd.int/aichi-targets/target/15

[6] See www.bonnchallenge.org/

Table 1.
Climate change and forest and landscape restoration pledges and initiatives since 1994

	Climate change	Forest and landscape restoration
1994	UNFCCC	
1997	Kyoto Protocol signed	
2000s		Notion of FLR developed
2003		Development and implementation of FLR projects GPFLR initiated
2007		Great Green Wall initiative established
2010		United Nations CBD Aichi Target 15
2011		Bonn Challenge
2013	Warsaw Framework for REDD+ adopted	
2014		NYDF Initiative 20 x 20 established
2015	Paris Agreement signed Intended nationally determined contributions established SDGs adopted	AFR100 established UNCCD LDN voluntary targets FAO Forest and Landscape Restoration Mechanism (FLRM) established
2019		UNCCD Great Green Wall Phase 2
2020	European Green Deal – aim for neutrality in 2050 Second round of NDCs	
2021	UNFCCC COP26 Glasgow, UK	Glasgow Leaders' Declaration on Forests and Land Use COP26 Global Forest Finance Pledge United Nations Decade on Ecosystem Restoration (UNEP–FAO) began
2022	IPCC AR6	World Forestry Congress State of the World's Forests
2030	Target: SDG 13 emissions to decline by about 45%	Target: Bonn Challenge Target: SDG 15.3 land degradation neutrality
2050	Climate neutrality	

degradation neutrality (LDN),[7] Target 15.3 of the SDGs[8] (aims to restore degraded land and achieve land degradation neutrality by 2030) and the United Nations Decade on Ecosystem Restoration.[9] Regional level commitments include the African Forest Landscape Restoration Initiative (AFR100)[10] which aims to bring 100 million ha of land into restoration by 2030 and Initiative 20 x 20,[11] a regional partnership to conserve and restore more than 50 million ha of degraded land in Latin America.

The recent UNFCCC COP26 held in November 2021 in Glasgow, United Kingdom of Great Britain and Northern Ireland, highlighted the significance of restoration to support the climate change mitigation and adaptation objectives. The Glasgow Leaders' Declaration on Forests and Land Use[12] built on existing processes to reduce deforestation and reaffirmed commitments to "conserve forests and other terrestrial ecosystems and accelerate their restoration." This pledge covers over 90 percent of global forests by endorsing countries (141) and aims to channel public and private finance to protect forests, with a target of 2030 to halt and reverse forest loss and land degradation. It also seeks to implement and, if necessary, redesign agricultural policies and programmes to incentivize sustainable land management. In this context, more than USD 20 billion in forest-related finance was mobilized, including through the COP26 Global Forest Finance Pledge.[13] which aims to collectively provide USD 12 billion between 2021 and 2035 to finance the protection, restoration and sustainable management of forests. The Collaborative Partnership on Forests (CPF)[14] at COP26 also recognized the need to scale up efforts to halt deforestation and forest degradation through further collaboration between countries and sectors as follow-up to the United Nations Secretary-General's call for "turning the tide on deforestation".

The State of the World's Forests (FAO, 2022) presents a blueprint to use increase engagement with, investment for and delivery of actions to halt deforestation and forest degradation (Rametsteiner, 2021). Recovery from the COVID-19 pandemic to ***build back better*** and greener also presents an opportunity for building on the restoration momentum and enhancing collaboration to halt forest loss and land degradation and implement restoration activities on the ground that enable more resilient social and ecological systems. This highlights the clear link between, and the valuable role that FLR can play in supporting, both the climate change mitigation and adaptation agendas, highlighting opportunities to create synergies between these objectives (WRI, 2018).

There is also a clear contribution of FLR to several commitments and targets relating to climate change adaptation and mitigation itself: for example, supporting forest-based adaptation and mitigation towards SDG 13 on Climate Action,[15] Reducing Emissions from Deforestation and Forest Degradation (REDD+), and as recognized components of the NDCs, national adaptation plans (NAPs) and national adaptation programmes of action (NAPAs).[16] Mechanisms and processes such as REDD+ have built on the importance of restoration of forests and forested landscapes for climate change mitigation and adaptation outcomes, in particular, with the "enhancement of forest carbon stock" as one of the five REDD+ activities.[17] However, while REDD+ implementation frequently focuses on activities to reduce deforestation, restoration strategies and FLR action plans are often only considered as a cobenefit and not always included in wider national and international GHG accounting (Pearson ***et al.***, 2017).

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[7] See www.unccd.int/actions/achieving-land-degradation-neutrality#:~:text=Land%20Degradation%20Neutrality%20(LDN)%20has,and%20spatial%20scales%20and%20ecosystems

[8] See https://indicators.report/targets/15-3/

[9] See www.decadeonrestoration.org/

[10] See https://afr100.org/

[11] See https://initiative20x20.org/

[12] See https://ukcop26.org/glasgow-leaders-declaration-on-forests-and-land-use/

[13] See https://ukcop26.org/the-global-forest-finance-pledge/

[14] See www.cpfweb.org/en/

Nationally determined contributions are one of the key instruments to achieve the global climate goal of the Paris Agreement. Countries are requested to communicate national climate plans and actions, including climate-related targets, policies and measures, depending on national circumstance, resources and abilities. The collective targets of the submitted NDCs are however not sufficient to meet the Paris Agreement goals (UNFCCC, 2021). Countries are requested to increase the climate ambition and target every five years. The incorporation of the potential role of biomass recovery of forests and landscapes through FLR to contribute to climate mitigation would provide countries with a strong path for raising the climate ambition in the NDC enhancement cycles and for the successful achievement of its targets (Brancalion and Chazdon, 2017).

Within the submitted NDCs, countries have broadly recognized the great potential role of forests and land-based action in climate change mitigation and adaptation (IUCN, 2020b). While integrated and quantitative FLR-aligned targets are included in NDCs[18] of the UNFCCC (Crumpler ***et al.***, 2019; IUCN, 2020b; WRI, 2018), the majority of these targets (88 of the 130 NDCs with FLR-aligned targets) are however conditional, representing 32 million ha and 3.2 billion tonnes of carbon dioxide equivalent (tCO_2eq). Comparatively, FLR-aligned unconditional targets represent 25 million ha and 53.6 million tCO_2eq. (Figure 4) This illustrates a potential lack of alignment of restoration and climate commitments, and translation of these into tangible actions. More can therefore be done to better link strategies and actions by fully integrating quantifiable and unconditional targets implemented within NDCs and those implemented to achieve other restoration commitments with tangible targets and indicators, e.g. REDD+ frameworks. The development of stronger connections between these, especially if existing quantitative restoration commitments such as the Bonn Challenge and LDN, and targets, policies and restoration measures are integrated in NDCs, have the potential to increase the restoration and climate change mitigation and adaptation impacts at scale.

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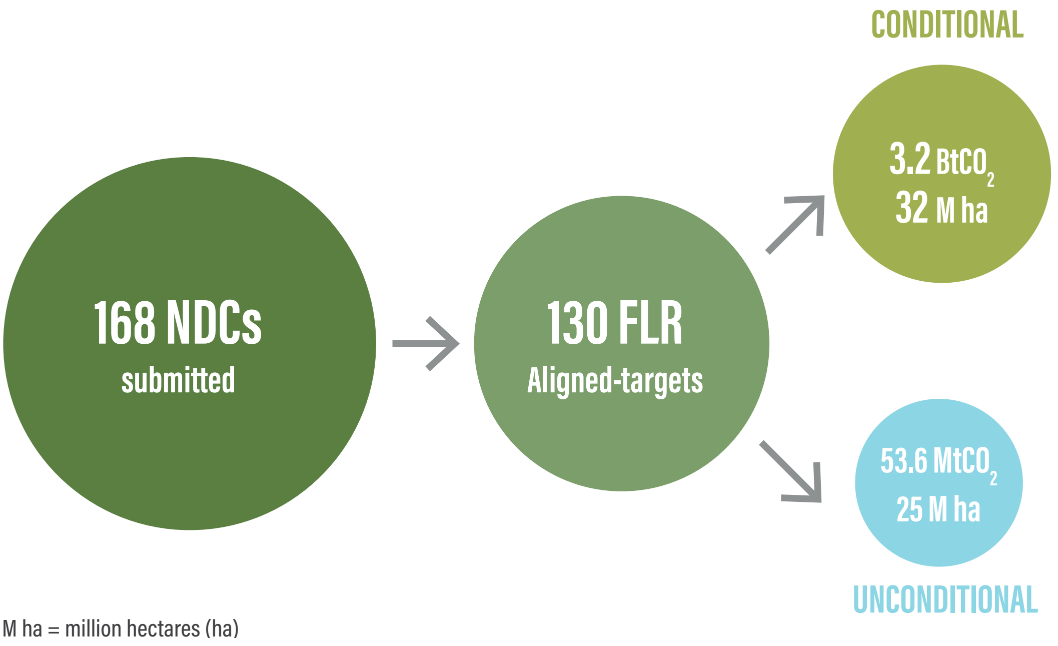
[15] See https://sdgs.un.org/goals/goal13

[16] An initiative established at the UNFCCC COP16 as part of the Cancun Adaptation Framework adopted in 2010.

[17] See https://unfccc.int/topics/land-use/workstreams/redd/what-is-redd

[18] Nationally determined contributions agreed by countries under the Paris Agreement 2015 to set long-term goals to increase their ability to adapt to the adverse impacts of climate change and foster climate resilience.

Figure 4
Nationally Determined Contributions (NDCs)



Source: Adapted from Crumpler *et al.* 2019

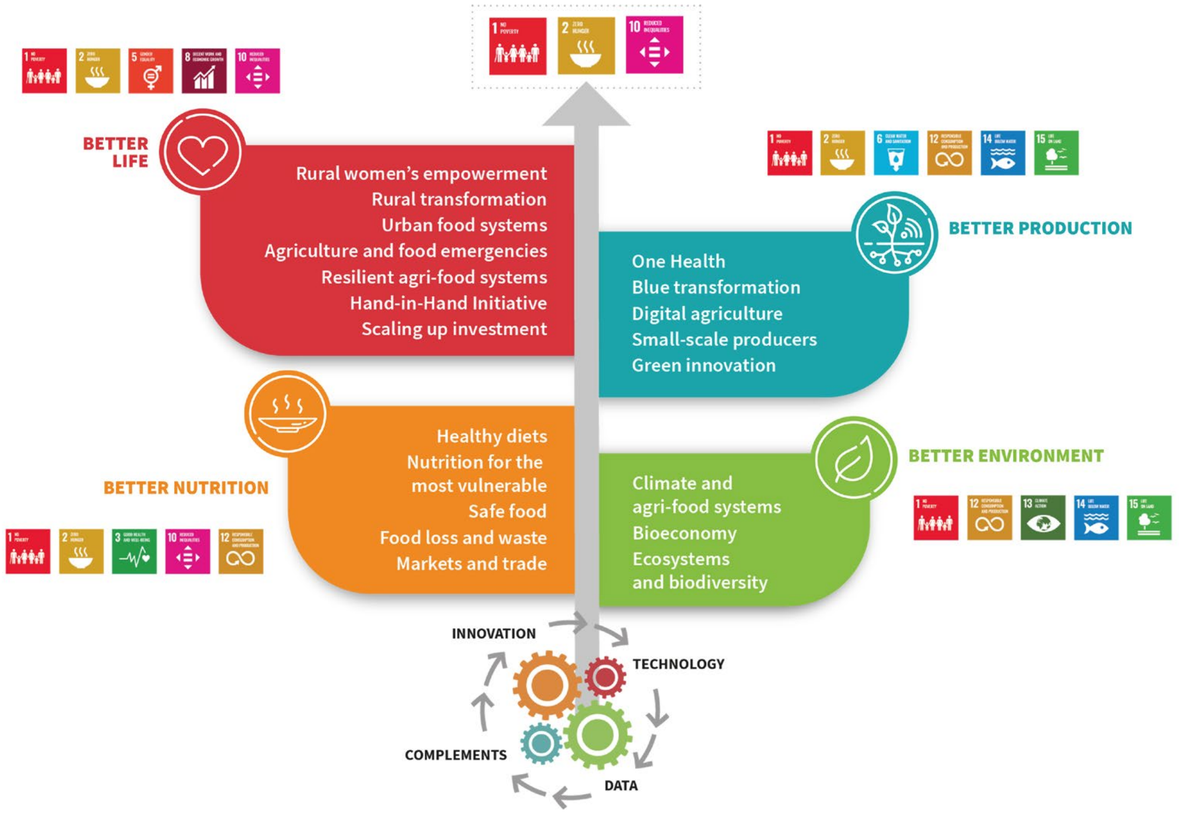
Forest and land restoration efforts are prominent in the latest round of national climate plans communicated under the Paris Agreement, or NDCs, with 74 percent of all countries promoting either adaptation or mitigation measures in their NDCs targeting the restoration, conservation or sustainable management of forests and land resources, particularly in Africa, Latin America and the Caribbean. As of 1 May 2021, 47 (out of 55) updated or enhanced NDC submissions mention forests, 26 of which have quantitative targets for mitigation (NYDF, 2021). The NYDF Goal 7 Progress Report (2021) notes that high mitigation potential countries (32 countries) offer 82 percent of total mitigation from reducing deforestation, 68 percent from improved forest management and 66 percent from afforestation or reforestation. This equates to 292 million t CO_2 per year of the economic mitigation potential (50 percent). Just under half of all second-round NDCs explicitly reference biodiversity as a cross-cutting priority for adaptation (Crumpler *et al.*, 2021).

In addition to integration into NDCs, there are many opportunities for forests to contribute to nature-based climate change adaptation solutions (Meybeck *et al.*, 2020). This is often dependent on the interaction between different sector policies that determine land and water use, e.g. land planning, water management, energy, infrastructure, finance and agriculture. National adaptation programmes of action and NAPs aim to align adaptation objectives with other economic sectors, including forests, water and environment in a more coordinated and coherent approach.

2.3. Forest and landscape restoration cobenefits in the 2030 Agenda for Sustainable Development

The 17 SDGs[19] adopted in 2015 aimed to help achieve peace and prosperity for people and the planet by 2030. As a United Nations organization, FAO is guided by the SDGs in its main domains of intervention: agriculture and food security (SDG 2, Zero Hunger), natural resources management and, in particular, forest management (SDG 15, Life on Land). The new strategic FAO engagements anchored on the four betters (better production, better nutrition, better environment, better life) claim even more concerns about the SDGs' achievement considering that all the goals are targeted by FAO's work (see Figure 5).

Figure 5.
FAO strategic results framework related to Sustainable Development Goals


BETTER LIFE
Rural women's empowerment
Rural transformation
Urban food systems
Agriculture and food emergencies
Resilient agri-food systems
Hand-in-Hand Initiative
Scaling up investment
BETTER PRODUCTION
One Health
Blue transformation
Digital agriculture
Small-scale producers
Green innovation
BETTER NUTRITION
Healthy diets
Nutrition for the most vulnerable
Safe food
Food loss and waste
Markets and trade
BETTER ENVIRONMENT
Climate and agri-food systems
Bioeconomy
Ecosystems and biodiversity
INNOVATION
TECHNOLOGY
DATA
COMPLEMENTS

Source: FAO. 2021. *The Director-General's Medium-Term Plan 2022–2025 and Programme of Work*. www.fao.org/3/ne576en/ne576en.pdf

While FLR was not initially conceived in response to the SDGs, it was developed around two main objectives: i) human well-being and ii) ecological integrity (Mansourian *et al.*, 2021; FAO, 2015). Over time, the concept of FLR has evolved and currently the newly launched United Nations Decade on Ecosystem Restoration has placed significant importance and high expectations on its links with the SDGs (see the first principle in Box 1), insisting on increasing the scale of action.

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[19] See https://sdgs.un.org/goals

The implementation of FLR activities throughout the restoration process has tremendous potential to support the achievement of numerous SDGs (Figure 6.6). Restoration goes beyond just tree planting: restored landscapes are biodiverse, carbon rich and climate resilient. They contribute to and are intrinsically linked to numerous SDGs, targeting a wide range of forest- and land-related goals and targets. Forest and landscape restoration directly addresses SDG 15 (Life on Land),[20] with SDG 15.3 aiming to achieve LDN through restoration of degraded land and soil and combating desertification. The restoration of aquatic biomes such as mangroves also supports work towards SDG 14 (Life before Water) (conserve and sustainably use the oceans, seas and marine resources for sustainable development), with SDG 14.2 taking action to restore marine and coastal ecosystems.

Forest and landscape restoration also directly and indirectly supports multiple SDGs by indirectly providing diverse cobenefits and cross-cutting opportunities, which, together work towards improved capacity for resilience to climate change. Deforestation and degradation of land is often due to a lack of alternative options for those heavily dependent on natural resources as the basis for their livelihoods and well-being (IPR, 2019. In addition, those most affected by land degradation are those most vulnerable,

Box 1

The first of the ten principles for ecosystem restoration to guide the United Nations Decade on Ecosystem Restoration

Restoration projects, programmes and initiatives at all spatial scales, from individual sites to large landscapes and seascapes, play an essential role in achieving ambitious global targets for sustaining life on Earth. Successful ecosystem restoration aims to contribute to the achievement of the 2030 Agenda for Sustainable Development and its 17 SDGs, which seek to end poverty, conserve biodiversity, combat climate change and improve livelihoods for everyone, everywhere.

The SDGs are unlikely to be met unless ecosystem degradation is stopped, and ecosystem restoration is undertaken at cumulative scales of hundreds of millions of hectares globally. Effective restoration simultaneously supports achievement of the biodiversity, climate and LDN goals of the Rio Conventions – CBD, UNCCD and UNFCCC – and allied global initiatives. Preventing, halting and reversing ecosystem degradation, as a contribution to global targets, is a shared responsibility among all public and private sectors and stakeholders at local, national and international levels.

Source: FAO, International Union for Conservation of Nature (IUCN) Commission on Ecosystem Management (CEM) & SER (Society for Ecological Restoration). 2021. *Principles for ecosystem restoration to guide the United Nations Decade 2021–2030*. www.decadeonrestoration.org/publications/principles-ecosystem-restoration-guide-united-nations-decade-2021–2030

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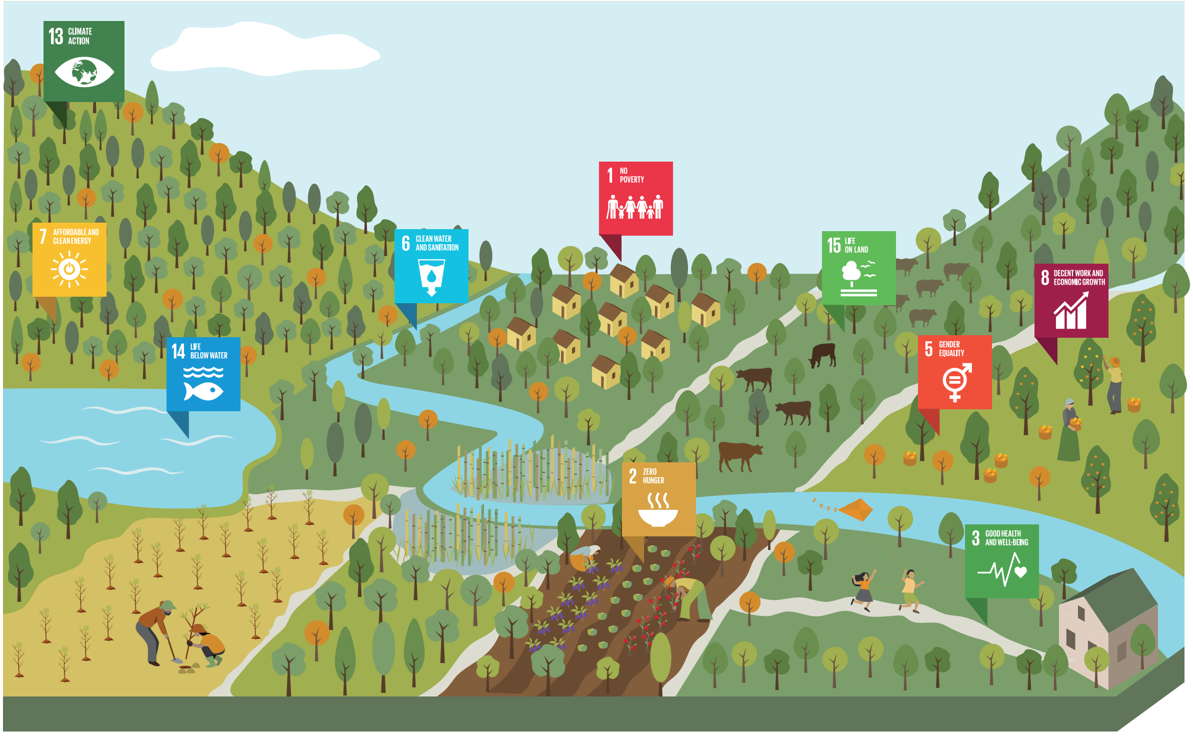
[20] See https://sdgs.un.org/goals/goal15

Figure 6.
The contribution of FLR to multiple Sustainable Development Goals


13 CLIMATE ACTION
7 AFFORDABLE AND CLEAN ENERGY
14 LIFE BELOW WATER
6 CLEAN WATER AND SANITATION
1 NO POVERTY
15 LIFE ON LAND
8 DECENT WORK AND ECONOMIC GROWTH
5 GENDER EQUALITY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING

continuing the vicious cycle of overexploitation and unsustainable use of natural resources. To support the reduction and eradication of poverty (SDG 1, No Poverty), land resources must be managed sustainably (IRP, 2019).

Restored soil fertility, through FLR activities such as, agroforestry, stabilizing water cycles and sustainable soil management practices, brings improved food security and nutrition outcomes (SDG 2, Zero Hunger). These practices can also support water security and water sanitation and hygiene (WASH) objectives under SDG 6, Clean Water and Sanitation (in particular, SDG 6.6 on protecting and restoring water-related ecosystems). These improved ecosystem services indirectly ensure healthy lives and promote well-being for all at all ages (SDG 2, Zero Hunger) for local populations, and forests also continue to be a unique source of natural elements used in medicinal products beneficial for human health.

Forest and landscape restoration aims to engage Indigenous Peoples throughout the restoration process. Their mobilization, in particular, through the development of sustainable and livelihood opportunities directly reinforces SDG 8 (Decent Work and Economic Growth) as well as SDG 1 (No Poverty). Through gender-responsive approaches, FLR also considers gender equality and works to empower women in project development and implementation (SDG 5, Gender Equality). Restoration activities related to the sustainable supply of forest-based products for energy contribute to SDG 7 (Affordable and Clean Energy).

By storing significant quantities of carbon, therefore mitigating climate change, and enabling more resilient communities and environments through improved ecological integrity and function, FLR also indirectly supports outcomes under SDG 13 on Climate Action. Restored landscapes protect communities and environments against the impacts of climate-related hazards and natural disasters. By working at landscape level, FLR-regenerated habitats aim to have long time horizons in their implementation. This allows for an adaptive approach to activities on the ground which can be key to improve resilience.

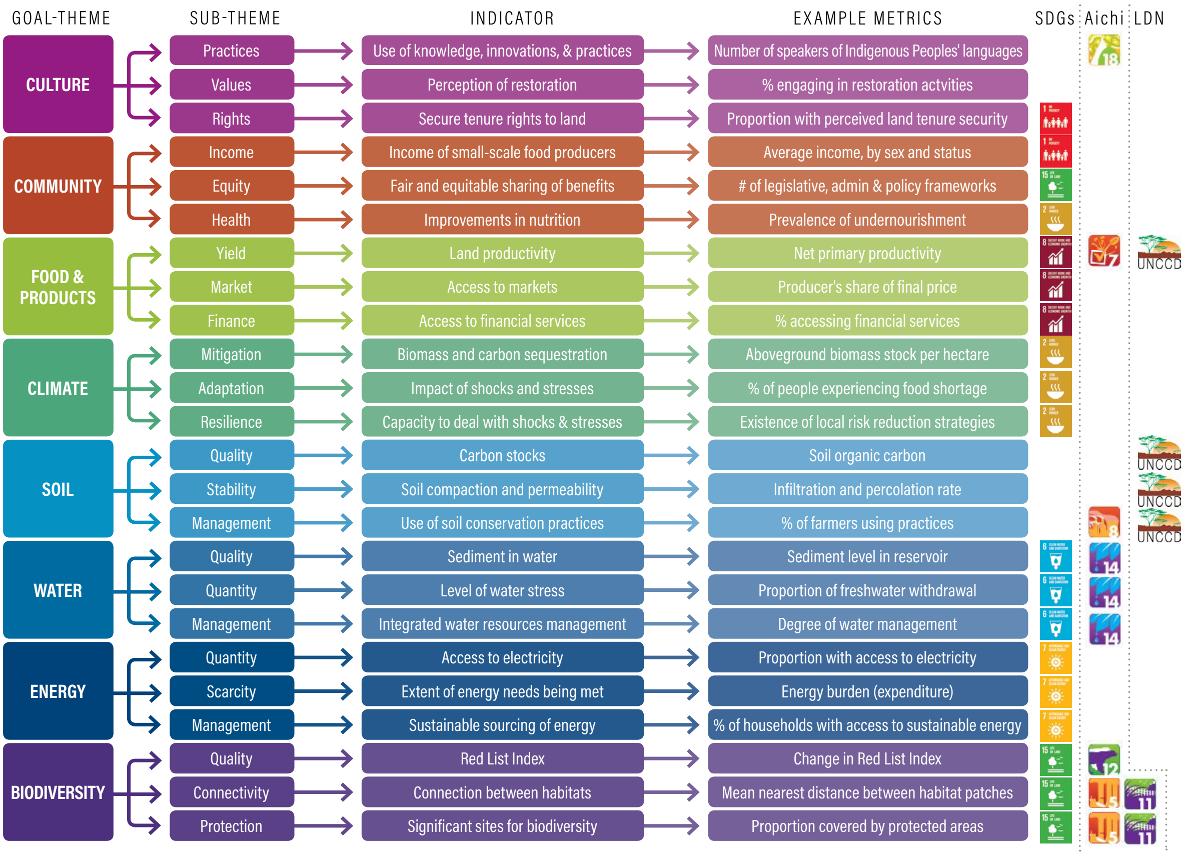
FAO's FLR approach is consistent with, and supportive of the balanced cross-sectoral integration that is an inherent part of the SDGs. This multidimensional nature of FLR projects is reliant on active stakeholder engagement to meet a diverse set of interests, capacities, objectives and needs. This can be supportive of outcomes under SDG 17 on Partnerships for the Goals. The development of projects and activities requires an understanding of local contexts and the trade-offs that may occur throughout the restoration process. The discussions and negotiations as part of FLR implementation encourages the creation of partnerships at national, regional and global levels.

The FAO FLRM team and the World Resources Institute (WRI) have developed a methodological tool that allows for better monitoring of FLR and, as a result, its impacts on SDGs (FAO and WRI, 2019). The Restoration Indicator Menu (Figure 7.7) aims to identify priorities and indicators for monitoring FLR. It can also illustrate linkages to SDGs, Aichi and LDN targets. The adoption of this methodology has illustrated that FAO FLR activities support the following SDGs in particular: SDG 1.2 poverty reduction, SDG 2.4 hunger reduction, SDG 7.3 clean and affordable energy, SDG 6.4 clean water, SDG 8.4 decent work and SDG 15, Life on Land protected (with a particular focus on SDG 15.3 on combating desertification, restoring degraded land and soil, including land affected by desertification, drought and floods, and striving to achieve a land degradation-neutral world).

While FLR objectives are typically guided by stakeholders rather than linkages to SDGs, the Restoration Indicator Menu illustrates the diversity of outcomes from the implementation of restoration activities to support multiple development targets and goals. The process of land restoration and rehabilitation at the landscape level enables the integration of multiple sectors, plans and programmes, and engagement of diverse stakeholders at local, national and regional levels. This comprehensive landscape approach not only supports the wider delivery of SDGs through the FLR process but also can maximize the impact of restoration to support climate change mitigation and adaptation agendas across these targets.

Efforts by the United Nations Decade on Ecosystem Restoration also include "Finance restoration on the ground" as one of the ten actions. The United Nations Decade aims to provide knowledge on how to finance ecosystem restoration and build capacity of stakeholders to raise finance. Recognizing that adaptation requires ecosystem

Figure 7.
A Restoration Indicator Menu developed from the United Nations conventions' entry points



GOAL-THEME	SUB-THEME	INDICATOR	EXAMPLE METRICS	SDGs	Aichi	LDN
CULTURE	Practices	Use of knowledge, innovations, & practices	Number of speakers of Indigenous Peoples' languages		18	
	Values	Perception of restoration	% engaging in restoration actvities			
	Rights	Secure tenure rights to land	Proportion with perceived land tenure security	1		
COMMUNITY	Income	Income of small-scale food producers	Average income, by sex and status	1		
	Equity	Fair and equitable sharing of benefits	# of legislative, admin & policy frameworks	15		
	Health	Improvements in nutrition	Prevalence of undernourishment	2		
FOOD & PRODUCTS	Yield	Land productivity	Net primary productivity	8	7	UNCCD
	Market	Access to markets	Producer's share of final price	8		
	Finance	Access to financial services	% accessing financial services	8		
CLIMATE	Mitigation	Biomass and carbon sequestration	Aboveground biomass stock per hectare	2		
	Adaptation	Impact of shocks and stresses	% of people experiencing food shortage	2		
	Resilience	Capacity to deal with shocks & stresses	Existence of local risk reduction strategies	2		
SOIL	Quality	Carbon stocks	Soil organic carbon			UNCCD
	Stability	Soil compaction and permeability	Infiltration and percolation rate			UNCCD
	Management	Use of soil conservation practices	% of farmers using practices		8	UNCCD
WATER	Quality	Sediment in water	Sediment level in reservoir	6	14	
	Quantity	Level of water stress	Proportion of freshwater withdrawal	6	14	
	Management	Integrated water resources management	Degree of water management	6	14	
ENERGY	Quantity	Access to electricity	Proportion with access to electricity	7		
	Scarcity	Extent of energy needs being met	Energy burden (expenditure)	7		
	Management	Sustainable sourcing of energy	% of households with access to sustainable energy	7		
BIODIVERSITY	Quality	Red List Index	Change in Red List Index	15	12	
	Connectivity	Connection between habitats	Mean nearest distance between habitat patches	15	5 11	
	Protection	Significant sites for biodiversity	Proportion covered by protected areas	15	5 11	

Source: Authors.

Source: **FAO & WRI (World Resources Institute).** 2019. *The road to restoration: A guide to identifying priorities and indicators for monitoring forest and landscape restoration*. Rome and Washington, DC. www.fao.org/3/ca6927en/CA6927EN.pdf

protection, restoration and management,[21] FAO has helped leverage funds through the main financial instruments of the international environmental conventions (UNFCCC, CBD, UNCCD). Some innovative initiatives, common incentives and diverse financial strategies are emerging. A shared trend is the recognition that the impact of climate change is exacerbated by the level of deforestation, forest cover and land degradation, while climate-related disturbances (floods, rising temperatures, limited rainfall, storms and heavy winds, fire, pest outbreaks) can contribute to increased forest loss and land degradation.

In this context, FLR interventions are conceived to increase the resilience of both forests, agroecosystems and the communities living in these forests and depending on them. Some projects address the environmental priorities by targeting forest cover, biodiversity conservation or ecosystem restoration. Others focus on the economic priorities by addressing NTFP production or the creation of employment opportunities with the ultimate aim of improving the livelihoods and adaptive capacities of rural communities.

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[21] Protection includes actions to maintain the integrity of natural ecosystems and the services they provide. Management refers to the sustainable use and conservation of resources. Restoration relates to "a planned process that aims to regain ecological integrity and enhance human well-being in deforested or degraded [forested] landscapes" (GPFLR, 2022).

Phnom Dek, Preah Vihear, Cambodia - Mrs. Tun Kien attaches the recently planted tree to a bamboo spike to help it grow straight. Community forests members are encouraged to participate in the restoration and maintenance activities.

©FAO/ Enric Català Conteras

3. The role of forest and landscape restoration in climate change mitigation

Mitigation focuses on the causes of climate change, the emission of GHGs and their accumulation in the atmosphere (Stanturf *et al.*, 2015). Interventions aimed at climate change mitigation work to reduce emission sources or to enhance GHG sinks, or both (IPCC, 2019). A diverse set of climate change mitigation measures exist that consider CO_2, CH_4 and N_2O emissions and uptake, targeting the use of diverse ecosystems and land uses. Different mitigation measures vary considerably in their potential to reduce emissions or enhance carbon sinks, as well as their impacts (positive or negative) on the capacity of communities for adaptation, their scalability and cost-effectiveness (Pörtner *et al.*, 2021).

The sequestration of carbon into sinks can be conducted either by increasing forest or vegetation area or increasing the amount of carbon stocks per unit area. It is estimated that the protection, improved management and restoration of forests, peatlands, coastal wetlands, savannahs and grasslands has the potential to reduce emissions and/or sequester 7.3 mean (3.9–13.1 range) $GtCO_2eq$ per year (IPCC, 2022b).

There is significant potential for FLR to enable substantial carbon storage and act as a climate change mitigation mechanism through activities such as reforestation and landscape restoration which aim to increase the productivity, diversity and functionality of degraded forests and ecosystems (IUCN, 2019). Currently if targets set out by the Bonn Challenge alone are achieved, benefits from restoration such as watershed protection, improved crop yields and forest products will generate approximately USD 179 billion per year (Stanturf *et al.*, 2015. This could also sequester up to 1.7 $GtCO_2eq$ per year, and an estimated total of 5.95 $GtCO_2eq$ sequestered if the restoration goal of 350 million ha is met by 2030. This has the potential to reduce the current emissions gap by 11–17 percent (Ritvi *et al.*, 2015; IUCN, 2019). However, currently, only 43 countries have included clear targets for mitigation through restoration (WRI, 2018).

There are clear opportunities for FLR to support climate change mitigation measures. Forest and landscape restoration activities such as reforestation, afforestation and the integration of trees into other land uses (e.g. agroforestry), can be relatively cost-effective mitigation options, especially when adapted to local socioecological contexts and considering local and distant trade-offs (Pörtner ***et al.***, 2021). To be sustainable, these approaches must link to ecological safeguards and value chains to enable commercial opportunities. For example, the commercial potential of ecotourism and NTFPs was identified by The Restoration Initiative in Isiolo, Kaikipia, Marsabit and Samburu counties in Kenya.[22] The Kenya Forestry Research Institute and the Gums and Resins Association of Kenya and other key partners carried out a value chain analysis of NTFPs (gum arabic, gum resins, agave sisalina, aloe, opuntia and bee keeping) to understand the challenges and opportunities of each value chain.

Measures that support and prioritize avoided deforestation, such as REDD+, in developing countries, can also have significant impact on the reduction of carbon emissions and removals from the AFOLU sector. REDD+ seeks to provide financial incentives to support the conservation and sustainable of forests, and to enhance forest carbon stocks. The Warsaw Framework for REDD+[23] was adopted at UNFCCC COP19 and is also recognized in Article 5 of the Paris Agreement. The UN-REDD Programme[24] supports countries in the design and implementation of REDD+ projects on the ground. The FLR approach also provides an effective basis for supporting the implementation of REDD+ activities, in particular with the active engagement of all stakeholders, including Indigenous Peoples, and supportive governance and enforcement initiatives.

The mitigation potential of restoration in relation to their forest-based pathways can vary considerably according to the magnitude and immediacy of mitigation as well as their cost-effectiveness and cobenefits (Cook-Patton ***et al.***, 2021). For example, natural regeneration of forests is often preferred over plantations due to the risk of monocropping, use of non-native species or low survival rates of saplings, which can reduce mitigation effects, together with the potential of land grabbing to plant trees (Yang and He, 2021). Technical constraints, the availability of ecosystems to restore, the cost of restoration and the political landscape (e.g. local and national champions, and policies that incentivize or hinder restoration (FAO, 2021b)) can further impact FLR's mitigation potential (Cook-Patton ***et al.***, 2021). These elements may impact how restoration activities are prioritized and, as a result, the additionality of their mitigation impacts. When implementing FLR with mitigation objectives, avoiding perverse incentives and ensuring equitable and fairly distributed benefits to Indigenous People and local communities should be considered to maximize mitigation while also avoiding further degradation. In addition, consideration should be taken as to the restoration approach.

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[22] See www.fao.org/in-action/forest-landscape-restoration-mechanism/resources/detail/en/c/1258403/

[23] See https://unfccc.int/topics/land-use/resources/warsaw-framework-for-redd-plus

[24] See www.un-redd.org/

Assisted natural regeneration (ANR) to restore hillside forest, Philippines

©FAO/Noel Celis

The FLR process can also support bioenergy, in particular the wood energy sector and its potential to contribute to mitigation opportunities (GBEP, 2020). Unregulated demand and markets for wood energy resulting in unsustainable wood use is one of the main drivers of the degradation of forests and forested landscapes. Sustainability in the sector is therefore a major concern, and understanding the opportunities for sustainable wood energy production and use to contribute positively to FLR is key. There are many ways to improve the sustainability of the wood energy sector in order to ensure that it positively contributes to FLR, as well as other environmental, social and economic objectives, including climate change mitigation. Improving the sustainability of wood energy value chains can reduce pressures on natural forests through better management practices and improved technologies. The sustainability of wood energy can be improved across the value chain, from biomass production and transformation to the production and use of bioenergy and its by-products.

The FLR approach contributes significantly to sustainable wood energy, from biomass production to transformation of sustainable wood energy value chains. Sustainable forest management is important in the production of biomass on the wood supply side. This includes FLR approaches, such as the establishment of community forests, conservation of protected areas, plantations, assisted natural regeneration (ANR) and the use of currently degraded lands. During the transformation of biomass, improved feedstocks (such as wood pellets, chips or briquettes) can increase the efficiency of the value chain, thus reducing pressures on forests. The sustainability of the wood energy value chain can also be enhanced with improved bioenergy technologies. For traditional bioenergy, this includes both the methods of charcoal production and the use of fuelwood in homes with improved cookstoves. The latter concerns the demand side of wood energy. Clean cookstoves can contribute to climate change mitigation, but also to climate change adaptation, through reducing the time to collect fuelwood – time that can be used for instance for income generating activities – and the development of a local value chain related to the manufacturing of clean cookstoves can be a possible source of income diversification. Finally, the use of by-products can also enhance the sustainability of the system. For example, the biochar produced as a by-product of the gasification process can be used as a soil amendment to boost soil fertility, increase agricultural yields and therefore improve livelihoods.

3.1. Carbon already stored as a result of forest and landscape restoration interventions

The mitigation role of FLR has already been explored (Rizvi *et al*., 2015). The figures, however, require updating and further methodologies need to be developed. Carbon sequestration from FLR may vary between different accounting methodologies, with different levels of uncertainty. Calculations with the new Ex-Ante Carbon Balance Tool (EX-ACT)[25] method (FAO, 2019) and other methods, compared with previous estimates, are examples, together with the use of maps categorizing results by geography (mountains, coasts, drylands, plains and tropical forests). Consideration of sequestration depending on factors such as the initial state of degradation, the reasons for degradation, the health of the forest or land, climatic conditions, and the type and mode of investments (mechanized, manual, passive or active) will also be important to clarify. Addressing these uncertainties will be important in illustrating the role of FLR in mitigation.

Carbon already stored in ecosystems must be protected and their stocks enhanced if the climate change target under the Paris Agreement of maintaining global warming to a 1.5 °C temperature rise is to be met. Carbon-rich biomes such as primary forests, peatlands and mangroves, which store irrecoverable carbon – that is, carbon that, if lost, cannot be recovered by 2050 when net zero emissions need to be met – have a high mitigation potential from protection, emphasizing the importance of keeping this carbon within biomass above and below ground (Noon *et al.,* 2021). Ecosystems such as peatlands, mangroves, old-growth forests and marshes that are at risk of degradation and deforestation contain at least 260 Gt of irrecoverable carbon. Peatlands, for example, cover only 3 percent of land surface, but they store as much as 30 percent of all organic carbon locked in soil. For example, the soil organic carbon stocks in the Central Congo Basin peatlands of the Democratic Republic of the Congo and of the Congo are estimated to cover 145 500 km^2 (approximately 4 percent of the entire

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[25] See www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act/en/

Congo Basin), storing approximately 30 billion t CO_2 (Cannon, 2021). Protection and restoration of peatlands (through rewetting and paludiculture) is particularly important considering their carbon stocks accumulate slowly and their loss cannot be easily reversed over the timescales needed (Goldstein ***et al.***, 2020; IPCC, 2022b).

Significant areas of peatlands remain intact, covering an estimated 4.5 million km^2 and storing more than 600 Gt of carbon, according to IUCN (2021c). They store approximately 21 percent of the total soil organic carbon globally (IPCC, 2022b). This equates to more than twice the carbon stored in the global forest biomass on 33 percent of the land (Joosten and Couwenberg, 2009; Temmink *et al.*, 2022). This is the equivalent of 0.37 Gt CO_2 sequestered annually. Drainage, clearing and subsequent wildfires of peatlands for agriculture, mining, plantations and other extractive industries produce significant emissions into the atmosphere, contributing approximately 5 percent of global GHGs (Joosten, 2015). They also emit carbon into waterways as dissolved organic carbon and particulate organic carbon. This reduces water quality in aquatic ecosystems and, over time, changes vegetation cover and causes biodiversity loss (FAO, 2014).

About 15 percent of the world's peatlands have been drained. This area covers less than 0.4 percent of the global land surface but has substantial impacts on GHGs. Emissions from drained and burned peatlands equal 10 percent of all annual fossil fuel emissions from the land-use sector, or 5 percent of all global, anthropogenic GHGs due to degradation and burning (Joosten, 2015). This contributes approximately 1.5 Gt CO_2 per year. These emissions levels place peatlands as the third largest emitting sector after cropping and livestock rearing, and net forest conversion. The loss of this carbon stored in peatlands has been described by scientists as a "carbon bomb" (Booth, 2021). Where peatland drainage and degradation has occurred, the restoration potential of these ecosystems through rewetting can be a high-impact and cost-effective mitigation measure, with other ecosystem services (such as hydrological regulation and biodiversity conservation) and socioeconomic cobenefits (Leifeld and Menichetti, 2018). They are also one of the key focus ecosystems of the United Nations Decade on Ecosystem Restoration 2021–2030.[26]

To estimate GHG emissions, monitor degradation, flooding, fires and fire risk, or restoration, and establish sustainable management, the mapping of peatlands is, however, essential (FAO, 2020b). FAO, a founding member of the Global Peatlands Initiative (GPI),[27] assists countries with peatland mapping, monitoring and improved management. The GPI also aims to support sustainable livelihoods and improve environmental services from peatlands and reduce negative impacts on peatland restoration and conservation. FAO provides support to map and monitor peatlands through its publication, *Peatland mapping and monitoring* (2020a), and the open-source peatland monitoring module on the System for Earth Observation Data Access, Processing and

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[26] See www.decadeonrestoration.org/types-ecosystem-restoration/peatlands

[27] See www.globalpeatlands.org/

Analysis for Land Monitoring (SEPAL) platform[28] (see Box 2). At country level, it has also helped support the development of the Indonesian Peatland Restoration Information Monitoring System[29] to present data on the condition and restoration status of peatlands across seven priority provinces in Indonesia, and Peat-GHG tool, an excel-based tool to provide ex-ante estimates on anthropogenic GHG emissions resulting from peatland management.

BOX 2

System for Earth Observation Data Access, Processing and Analysis for Land Monitoring platform

The System for Earth Observation Data Access, Processing and Analysis for Land Monitoring (SEPAL) platform was launched in 2015 by the Open Foris team in FAO's Forestry Department. It aims to support FAO Member Nations generate forest data that is accurate, open and transparent to support forest and climate actions and ambitions. The platform facilitates access to data to inform land-use management decisions and monitor their impact on adaptation outcomes. Phase II of the SEPAL platform was launched in November 2021 and will have a particular focus on supporting countries' efforts in halting tropical deforestation and forest degradation, as well as loss of soil organic carbon from peatlands and organic soils, including in agricultural lands. With the generation of high-integrity forest and land-use data, it also aims to enable countries to attract public and private carbon finance for action on climate change mitigation through forests.

To preserve carbon storage, tools such as the Global Soil Organic Carbon Map (GSOC map)[1] have also been developed by the Global Soil Partnership and its Intergovernmental Technical Panel on Soils in 2017 to support SDG 15.3.1. National soil organic carbon maps calculate soil carbon stocks and, when shared within the GSOC map, help build a more precise and reliable global view on soil organic carbon. This can support their consideration in NDCs and REDD+ mechanisms for setting targets around emissions reductions from peatland ecosystems (López Gonzales *et al.*, 2020).

The section will include discussions on different pledges (often reported in ha or number of trees) and the reality, including gaps in data on carbon pools measured or not measured, gases, etc. The question of duration of projects, conditions of carbon storage (including its permanence) will be discussed, as well as the high mitigation potential of restoring carbon-rich ecosystems such as peatlands and mangroves.

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[1] See www.fao.org/global-soil-partnership/pillars-action/4-information-and-data-new/global-soil-organic-carbon-gsoc-map/en

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[28] See https://sepal.io/

[29] See https://en.prims.brg.go.id/

3.2. Potential for carbon storage and biodiversity enrichment to support ecological resilience through new forest and landscape restoration projects under the Bonn and other pledges

Many international restoration and climate action commitments aim to achieve different objectives "measured" by specific global environmental indicators at specific milestones. These include indicators such as carbon neutrality, net zero emissions, area of forest carbon preserved, key biodiversity areas, land restoration and zero deforestation commodities. The integrity and credibility of country commitments specific to carbon neutrality must be carefully evaluated: Are they ambitious enough? Do they rely too much on hypothetical negative emissions? Do they have positive or negative impacts on SDGs? Until recently, the assessment and tracking of the implementation of these commitments made by parties and all stakeholders remained largely unknown. The lack of simple methodologies, available data, and activity and baseline information, among other parameters, made it difficult to support countries to implement and monitor their commitments, and, most importantly, plan their policy and actions towards the goals of the conventions.

Supporting tools

Numerous GHG accounting tools have been developed (Colomb *et al.*, 2013; Toudert *et al.*, 2018), but they currently do not support countries and stakeholders in the global commitments made under conventions or climate and restoration pledges. Nor do they allow for the annual tracking and reporting at specific milestones needed to support the road map for a sustainable planet.

FAO has co-developed and is using several methodologies and tools to measure mitigation progress and help improve operational opportunities. These include the EX-ACT, B-INTACT, ABC-Map and NEXT.

The EX-ACT[30] is a land-based accounting system, based on the IPCC methodology for GHG emissions inventories. It assesses the impact of a set of activities from all sectors of AFOLU at project level and estimates its impact on the carbon balance and biodiversity over 20 years. This provides a cumulated carbon balance over 20 years (i.e. emissions or sinks of carbon) and the project's annual GHG emissions average per unit of land, expressed in tCO_2eq per ha. This can be disaggregated per activity or a total of all the activities in each scenario (initial, without project and with project). The climate mitigation impact of AFOLU investments, projects, programmes and policies, such as restoration, at all stages of their lifetime at any level (local, regional and national) can then be identified, which can support and enable access to international financing institutions funds. EX-ACT can also strengthen national stakeholders' capacity to estimate and monitor project goals in terms of emissions reduction. It can also support policymakers to integrate mitigation objectives into national strategies and international commitments.

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[30] See www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act/en/

The original scope of EX-ACT was to provide ex-ante estimates of GHG fluxes. This objective has now developed to provide a higher level of flexibility and sophistication to enable the tool's suitability for ex-ante, during and ex-post appraisals. The latest version of the EX-ACT tool (9.3) includes an annual indication of the carbon balance, providing an indication of the GHG fluxes at any given year of analysis (in addition to the previously available annual average values). The tool is now also suited for analysis over any period, although 20 years is recommended as a standard projection for project assessments.

The Biodiversity Integrated Assessment and Computation Tool (B-INTACT)[31] is a land-based accounting system that uses a quantitative and qualitative approach to assess the impact of project-level activities in the AFOLU sector on biodiversity, which are often not accounted for in conventional carbon pricing. The quantitative approach assesses direct anthropogenic impacts on biodiversity from land-use changes, habitat fragmentation, and infrastructure and human encroachment, expressed in the mean species abundance (MSA) metric. The MSA metric is translated into policy indicators, providing key information such as area (ha) of biodiversity loss or the monetary value of ecosystem services. The qualitative assessment guides the contextualization of the area, accounting for protected areas, key biodiversity areas and share of threatened species. It also assesses the project's intended impacts on the landscape and agrobiodiversity, including its effects on invasive species.

Both EX-ACT and B-INTACT provide decision-makers with policy indicators to estimate and monitor the carbon and biodiversity impact of investments, projects (or potential projects) and policies, for AFOLU, using globally recognized environmental assessment methodologies and reliable datasets. This information and the analysis can also support countries in accessing funds from international financial institutions (IFIs) to finance project implementation.

More recently, FAO have collaborated to develop two further environmental tools related to climate change mitigation, adaptation, and biodiversity and ecosystem restoration: the Adaptation, Biodiversity and Carbon Mapping tool ABC-Map, and the Nationally Determined Contribution Expert Tool NEXT.

ABC-Map allows governments, international funds, agricultural banks and other stakeholders to holistically assess the environmental impact of national policies and plans (e.g. NDCs and NAPs) and investments in the AFOLU sector. ABC-Map aligns with the objectives of the three Rio Conventions, UNFCCC, CBD and the UNCCD. The tool covers three main sections, each of which offers the user a range of indicators for both the baseline and project situation. The three topics are:

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[31] See www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/b-intact/en/

1. Adaptation (e.g. aridity index, temperature anomalies and erosion risk).
2. Biodiversity (e.g. MSA, land-use evolution in protected and key biodiversity areas, and natural capital), and carbon (e.g. evolution of the carbon stock, carbon balance and social value of carbon).
3. Carbon (e.g. evolution of the carbon stock, carbon balance and social value of carbon).

NEXT is a land-based accounting standard for national and subnational GHG reduction goals. It measures annual carbon stock changes per unit of land (in ha), CH_4 and N_2O emissions, expressed in tCO_2eq per year. NEXT provides the annual and cumulated estimation of the potential changes in GHG emissions from a set of climate actions over a 30-year reading grid. It aligns with the Enhanced Transparency Framework (UNFCCC, 2022) of the Paris Agreement ambition mechanisms providing a 30-year reading grid, to report and track at multiple points in time the climate mitigation commitments of parties and other stakeholders:

- before the implementation of a climate action to evaluate its potential changes on GHG emissions reductions;
- during the implementation of a climate action to assess and report progress towards the mitigation goal, and evaluate additional GHG emissions reductions to achieve the mitigation commitments; and
- at the end of the climate action period to assess its achievement in term of GHG emissions reductions.

These tools can support restoration intervention activities to assess their mitigation potential at project and national or subnational levels. At national level, they can be integrated into or used to support NDCs and illustrate how FLR implementation can contribute to national-level climate change mitigation objectives, in particular, for the development and implementation of country-led projects combating land and forest degradation. They can also be used in combination with other tools that assess the GHG emissions impacts of sector-specific projects, such as the Global Livestock Environmental Assessment Model (GLEAM-i),[32] which assesses the GHG emissions using IPCC Tier 2 methods for intervention scenarios in animal husbandry, feed and manure management. Where livestock is an important contributor to deforestation, and forest and land degradation, GLEAM-i can be used in combination with EX-ACT to analyse the potential impacts of FLR on the carbon balance.

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[32] See https://gleami.apps.fao.org/

3.3. Conditions for avoiding risks of reversals in forest and landscape restoration interventions

Forest and landscape restoration interventions are delicate (Mansourian *et al.*, 2021). First, they are designed with activities for long-term outcomes, with 20, 30 or 50 years often required to manage good restoration with real climate benefits. Second, FLR is also usually a response to huge pressures and degradations that cannot be overcome simply; the cause of degradation must be addressed. Finally, FLR often intervenes in complicated socioeconomic situations (Mansourian *et al.*, 2021), with considerable conflicting interests. Forest and landscape restoration therefore requires stabilization efforts to avoid either a slowing down or even the reversing of climate benefits.

To support and guide the realization and long-term implementation of FLR programmes, the United Nations Decade on Ecosystem Restoration Task Force on Best Practices has launched a checklist of ten principles that should guide the realization of FLR programmes (see Box 3).

Box 3

Ten principles to underpin ecosystem restoration programmes (United Nations Decade on Restoration's Task Force on Best Practices)

1. contribute to the United Nations SDGs and the goals of the Rio Conventions ;
2. promote inclusive and participatory governance, social fairness and equity from the start and throughout the process and outcomes;
3. includes a continuum of restorative activities;
4. aim to achieve the highest level of recovery for biodiversity, ecosystem health and integrity, and human well-being;
5. address the direct and indirect causes of ecosystem degradation;
6. incorporate all types of knowledge and promote their exchange and integration throughout the process;
7. are based on well-defined short-, medium- and long-term ecological, cultural and socioeconomic objectives and goals;
8. are tailored to the local ecological, cultural and socioeconomic contexts, while considering the larger landscape or seascape;
9. include monitoring, evaluation and adaptive management throughout and beyond the lifetime of the project or programme; and
10. are enabled by policies and measures that promote their long-term progress, fostering replication and scaling-up.

Source: **FAO, IUCN CEM & SER.** 2021. *Principles for ecosystem restoration to guide the United Nations Decade 2021–2030*. Rome, FAO. www.fao.org/3/cb6591en/cb6591en.pdf

These principles can support decision-makers and donors, as well as provide practical advice for practitioners (FAO, IUCN CEM and SER, 2021; Stanturf *et al.*, 2020). Mansourian ***et al.*** (2021) have tentatively classified the conditions of success or failure for preventing the reversing of FLR in two categories: human-induced (directly or indirectly) or natural factors not directly attributable to society (depending for instance on existing and future climatic conditions).

Human-induced factors

Changes in local policies, such as new decisions on land-use planning, may be taken after the start of an FLR initiative. Conversion to other land use, for either fuelwood collection or new agricultural or mining development can occur as a result (Höhl ***et al.***, 2020). Consequently, political engagement in FLR at local, regional and national level is key (WRI, 2018). Policy changes can also translate in the loss of confidence of donors, especially from the private sector, which may lead to the termination of funding, with severe consequences. To avoid such risks, investments should be made with a clear understanding of the local socioeconomic and political context, identifying who will benefit and who could lose. Participatory decision-making is therefore an overarching condition of success.

Security and governance issues such as terrorism, violent conflicts or corruption can also impact FLR outcomes, significantly or completely disrupting local governance and power structures. Where control is lost in forested areas, restoration efforts can be erased, and corruption can continue to drive illegal extraction, further degrading forests (Mansourian ***et al.***, 2021).

Human error may also slow or limit FLR outcomes. For example, the use of poor quality or inappropriate seed or species not adapted to the restoration site, planting the wrong species, continued uncontrolled grazing or anthropogenic fires (sometimes driven by traditional agriculture slash-and-burn methods), poor plantation management or insufficient irrigation may all contribute to poor restoration results (Höhl ***et al.***, 2020).

Natural (including climate) induced factors

The most detrimental reversing effects of FLR are uncontrolled fires, burning biomasses and a return to cycles of degradation. Other natural events that may reverse the efforts of restoration include natural fires, landslides, volcanic eruptions, earthquakes and tsunamis. The increased occurrence of climate-induced extreme weather events (e.g. severe drought and cyclones) or disturbances such as pest outbreaks are increasingly responsible for the high risk of FLR failure.

Restoration efforts should not lead to land degradation elsewhere (IUCN, 2021a). Ultimately, successful FLR requires addressing the drivers underlying deforestation and degradation (Stanturf ***et al.***, 2020). Environmental vulnerability, as well as past trends and projections of biophysical and climatic conditions must therefore be clearly identified. In particular, the impacts of anticipated climate change on temperature, water availability and yield potential, together with human pressures must be considered in the implementation of FLR to ensure long-term sustainability of restoration efforts. Tools such as FAO's Modelling System for Agricultural Impacts of Climate Change (MOSAICC)[33] have been developed to analyse the potential impact of climate change at national level and help policy and decision-makers develop adaptation strategies, programmes, projects and investments.

To gauge the level of commitment required to guarantee long-term political engagement, efforts to understand recent climate change national strategies (including NDCs), and other institutional settings and policies should also be made. For example, the recent COP26 highlighted the parties' renewed interest in restoration solutions as seen in the Glasgow Leaders' Declaration on Forests and Land Use, with a commitment to conserve forests and other terrestrial ecosystems and accelerate their restoration. Civil society partners have also shown increased interest for nature-based solutions such as FLR in the context of the United Nations Decade on Ecosystem Restoration, as demonstrated during the 2021 IUCN World Conservation Congress, Marseille, France (IUCN, 2021b). Consistent demonstration of climate change mitigation and adaptation benefits, together with other key returns, such as biodiversity, food security and livelihoods can build on this momentum. The establishment of monitoring systems to illustrate these benefits and cobenefits can inform donors, building their confidence in FLR outcomes, and support the development of new restoration project proposals.

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[33] See www.fao.org/in-action/mosaicc/en/

4. The role of forest and landscape restoration in climate adaptation and resilience

The IPCC (2007) defines adaptation "as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities". In the context of FLR, adaptation means:

> Changing management practices to decrease the vulnerability of forests to climate change as well as implementing activities to reduce the vulnerability of the forest-dependent populations, and adopting climate-resilient restoration and management approaches, for example restoration with species appropriate to the evolving changes in climate (Rizvi *et al.*, 2015).

An adaptation benefit is, therefore, a "quantified and/or equivalently defined output or outcome of an adaptation activity"(African Development Bank, 2020). Adaptation benefits in FLR are therefore those outputs or outcomes of the changed management practices that decrease the vulnerability of forests and forest-dependent populations to climate change.

It is widely known that forests provide important environmental services at the local (within a catchment or watershed), national and global levels. These include soil conservation, regulation of the water cycle and hydrological regimes of streams and rivers, aquifer recharge, which provides a stable water supply for drinking, irrigation and hydropower generation. It also reduces peaks during intense rain event and flood protection, stabilizes slopes and riverbanks, and supports localized climate regulation. Many of these ecosystem services are crucial to support agricultural production to adapt to extreme climate events.

FAO promotes an ecosystem-based approach to adaptation through a broad range of silvicultural techniques for forest planting, regeneration and harvest for enhanced ecosystem services and livelihoods. A common response to unsustainable shifting cultivation is the demonstration and promotion of agroforestry systems. These act as buffer zones for the forests and regulate the microclimate, therefore reducing the vulnerability to extreme climatic events.

Restoration of degraded forest land through ANR for increased adaptive capacity is intended to climate-proof the area under reforestation to counteract risks associated with climate variability and change. Silvicultural techniques used include planting, maintenance and protection of climate hardened tree seedlings, improved wooded fallows, especially relatively long-duration (circa 10 years) wooded fallows that have been proven to be more effective for restoring soil fertility, while also increasing the production of forest products from the fallows. The use of native plant species based on the agroecological characteristics of each site is crucial. Forest and landscape restoration practices also include interventions (e.g. pruning and thinning) that focus on reducing the risk from forest fires and pest outbreaks (given that these risks are expected to increase with climate change).

The scales of interventions have also changed. Restoration is often implemented beyond administrative borders, focusing on ecological corridors and watersheds. Ecological corridors, connecting core zones such as the neighbouring natural reserves and remaining patches of forests, help maintain and recover cohesion in the fragmented forest ecosystems. It is estimated that, through the reforestation and the connection of fragmented habitats, the viability of animal and plant species is improved, which contributes to building more resilient forest ecosystems.

Agroforestry systems are also important to diversify local production systems and reduce dependence on single crops, which will reduce the risk of climate-induced economic losses. For example, the diversification of income sources through NTFP exploitation by vulnerable communities is a frequent response to reduce the risks of climate change.

The FLR process aims to regain ecological integrity and enhance human well-being in deforested or degraded forest landscapes, restoring forest ecosystems as part of larger landscape management changes, rather than through isolated restoration projects. It has the potential to provide equally large adaptation and mitigation benefits. Although previously, forests were mainly considered for mitigation purposes and rather ignored for adaptation, progress is being made in highlighting adaptation benefits for communities and ecosystems (Rizvi *et al.*, 2015). Forest and landscape restoration can result in adaptation measures and support for NAPAs and NAPs. As of 2020, several NAPs incorporated restoration activities, for example, restoration of mangroves in Djibouti contributing to controlled erosion, the restocking of fisheries and adaptation of coastal zones (Maybeck *et al.*, 2020). Further communication to illustrate these links is needed for policymakers and investors to be convinced of this. Women and youth also need to be engaged and included throughout the restoration process to enable a gender-responsive approach that ensures the adaptation and resilience of different land users.

Gender-responsive restoration

Climate change has inequal impacts across genders and marginal groups. Restoration strategies and solutions need to reflect the differentiated roles and responsibilities of these groups, in particular the recognition of land ownership. While women typically carry out a majority of agricultural and household work in many parts of the world, they lack the same access to financial and other resources and the ability to acquire land, and power in decision-making as men, and are more likely to live in poverty since this lack of inclusion increases their exposure.

The empowerment of women and gender equality in different cultural settings has significant implications for restoration, and vice versa. Restoration efforts may be undermined if these groups are excluded from the restoration process. Vulnerability to climate change also disproportionately affects women. Economic migration from unproductive and degraded landscapes often leaves women with greater economic burdens in rural areas. Climate-related risks, particularly in urban areas, such as extreme weather events, water shortages and heat waves can also deepen inequalities and increase the risk of gender-based violence. These factors have been intensified by the impact of the COVID-19 pandemic, undermining development gains.

The implementation of restoration itself can also provide a crucial opportunity for women's economic empowerment and, consequently resilience to climate shocks. Gender-responsive FLR should therefore be integrated throughout the restoration process to ensure more equitable outcomes for both restoration and climate resilience. This can leverage synergies between restoration commitments, climate change mitigation and adaptation agendas (especially linked through NDCs), and SDGs (Djoudi and Brockhaus, 2011, IUCN, 2017). Gender mainstreaming is a cross-cutting theme of Scaling-up Climate Ambition on Land Use and Agriculture through NDCs and NAPs (SCALA) programme co-led by FAO and the United Nations Development Programme (UNDP) with funding from the International Climate Initiative (IKI).

4.1. Flagship forest and landscape restoration projects: how to bring real adaptation benefits

From the project management perspective, achieving adaptation benefits from FLR projects is the result of the successful design, implementation, monitoring and impact evaluation of adaptation activities.

In recent years, significant progress has been made in developing methodologies to ensure that adaptation actions are designed to address context-specific climate risks. For example, in 2019, driven by the update of its Environmental and Social Safeguard policy, the GEF introduced standard requirements for climate-risk screening and climate-risk management, which need to be followed by its partner agencies (STAP, 2019). At a minimum, each agency should use a risk-screening process that includes four steps (hazard identification, assessment of vulnerability and exposure, risk classification, risk mitigation plan), rank risks according to a clearly defined scale, and uses the best available data (GEF, 2019a).

Other screening tools are also available from the World Bank,[34] the Asian Development Bank (2014), the World Meteorological Organization (2013), USAID,[35] and DFID (2003), among others. Sectoral tools, such as FAO's climate-risk screening tool (FAO, 2021b) have also been developed. Most recently, the European Union (2021) has introduced the taxonomy regulation which defined the screening criteria to determine the conditions under which "an economic activity qualifies as contributing substantially to climate change adaptation or mitigation and whether it does not cause significant harm to the environmental objectives".

An analysis of recent FLR projects and project concept notes under the GEF-7, GCF and Adaptation Fund (AF) between 2020 and 2021 identified how climate risks, vulnerabilities and adaptation options were included in FLR design and implementation (Table 2.). GEF is the largest provider of climate finance to the forestry sector – investing USD 3.4 billion and leveraging more than USD 17 billion in cofinancing from a range of partners for climate-related SFM activities since 1992 (GEF, 2022) –only introducing guidance for climate-risk screening and risk assessment in 2019. The GCF, established under the UNFCCC in 2010, aims to provide funds at scale to support developing countries limit or reduce their GHG emissions and help vulnerable societies adapt to the unavoidable impacts of climate change.

The AF [36] was established in 2001 and aims to finance projects and programmes to help vulnerable communities in developing countries build resilience and adapt to climate change. An increasing challenge for vulnerable countries and communities are the disproportionate impacts of climate change. Those most vulnerable are often significantly impacted by extreme weather events, desertification, rising sea levels, worsening food security and availability of fresh water. Finance to support vulnerable communities adapt to climate change requires significant resources beyond those already set to meet development objectives. Since 2010, the fund has committed USD 850 million over 100 countries. It has also established direct access to empower countries to directly access funding and develop projects through accredited national implementing entities.

The use of GEF as a source of FLR project examples was chosen to reflect their climate-risk screening and risk assessment. Three main criteria used to analyse these projects were:

1. Climate-risk assessment performance: 1. hazard identified; 2. vulnerability and exposure assessed; 3. risk classified; and, 4. risk mitigation plan proposed.
2. Climate adaptation options and benefits clearly defined.
3. Clear connection between FLR and adaptation established.

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[34] See https://climatescreeningtools.worldbank.org/

[35] See www.climatelinks.org/resources/climate-risk-screening-and-management-tools

[36] See www.adaptation-fund.org/

Table 2.
FAO flagship projects under the Global Environment Facility, Green Climate Fund and Adaptation Fund with climate change adaptation and mitigation outcomes

Country	Funder	Project name	Challenge addressed	FLR intervention	Climate change outcome
Burundi	GEF	Natural landscapes rehabilitation and climate change adaptation in the region of Mumirwa in Nujumbura	Deforestation, flooding, soil erosion	Reforestation of degraded woodland through SFM	Resilience against drought, extreme weather events and soil erosion Improved hydrological cycle
Cuba	GCF	Increased climate resilience of rural households and communities through rehabilitation of production landscapes	Droughts increasing invasive species and pests Extreme local temperatures	Rehabilitation of forests and soils, development of livelihoods	Adaptation: livelihood diversification Increased ecosystem resilience Local climate regulation
Democratic Republic of the Congo	GEF	Community-based miombo forest management in South-East Katanga	Deforestation and forest degradation	Forest management fund developed as well as co-management by communities	Carbon sequestration, reduced emissions Resilience – livelihood development
El Salvador	GEF	Climate change adaptation to reduce land degradation in fragile watersheds located in the municipalities of Teistepeque and Candelaria de la Frontera	Land degradation, deforestation, reduced water quality and quantity	Promotion of integrated natural resources management and climate change adaptation to increase vegetation cover and manage watersheds	Increased livelihood and ecosystem resilience Mainstreaming climate change adaptation and disaster risk reduction into fragile micro watershed plans

Country	Funder	Project name	Challenge addressed	FLR intervention	Climate change outcome
Lebanon	GEF	Smart adaptation of forest landscapes in mountain areas	Vulnerability to fire and pest outbreaks, habitat loss	Targeted guidance and capacity building to reforest and protect cedar corridors to improve management of cedar tree habitat	Habitat fragmentation decreased Increased climate resilience of cedar populations Increased socioeconomic resilience of communities
Madagascar	GEF	Biodiversity conservation, restoration and integrated sustainable development of Lower Mangoky and South-Mananara watershed	Vulnerability to extreme weather events (cyclone and drought), heatwaves and increased rainfall variability	Strengthened enabling environment to mainstream FLR and biodiversity, sustainable land management. Livelihood development and diversification	Resilience: livelihoods, improved food security
Nepal	GCF	Building a resilient Churia Region	Deforestation and forest degradation, landslides and soil erosion, vulnerability to flood events and rainfall variability	Restoration of forest, agroforestry, sustainable agricultural irrigation, improved water management	Avoided emissions Resilience: improved water and food security Reduced erosion, landslides and sedimentation
Pakistan	GEF	Reversing deforestation and degradation in high conservation value chilgoza pine forests	Erosion and overharvesting, vulnerability to flood events	Support development of sustainable land management institutions (payments for ecosystems services (PES), ANR, value chain development	Resilience: livelihood development, reduced flood events

Country	Funder	Project name	Challenge addressed	FLR intervention	Climate change outcome
Paraguay	GCF	Poverty, reforestation, energy and climate change	Unsustainable firewood harvesting	Close-to-nature planted forests, development of a sustainable bioenergy value chain	Resilience: livelihood diversification Decreased deforestation and forest degradation
Sudan	GCF	Gums for adaptation and mitigation in the Sudan	Vulnerability to extreme climate events, reduced rainfall, poor livelihood development Crop stress Degraded landscapes	Restoration of climate-resilient gum agroforestry, reforestation of degraded lands, development of value chains	Enhanced capacity of communities Support climate-resilient gum production Restoration of carbon sink potential of the gum arabic belt Expansion of Africa's Great Green Wall and contribution to the National REDD+ Strategy
Vanuatu	AF	Enhancing livelihood resilience in Vanuatu through FLR	Vulnerability to extreme events (cyclones), soil erosion Increased rainfall variability	Development of a national Forest and Landscape Restoration Strategy (FLRS)	Reduced soil erosion Increased resilience to extreme events through coastal protection Development of funding proposal to the AF to scale up restoration

Climate-risk assessment in forest and landscape restoration projects

Of the 15 approved GEF-7 concept notes, ten included all four of the main climate-risk assessment components, with identified hazards, vulnerability and exposure assessed, classification of risks and a risk mitigation plan. A clear link between the identification of climate risk and risk mitigation was observed, for example, in the case of Madagascar (GEF, 2019b).

In this project, the clear link starting from risk identification to risk mitigation is observed. It is evident from the fact that the assessment identifies extreme weather events (drought and cyclones) as the main climate hazards, along with out-of-season rainfall variability and extreme heatwaves. Future climate projections included increased precipitation variability and temperatures. Some of the crops grown in project target area, such as cassava, are expected to experience more pests with warming temperatures. The main drivers of land degradation and deforestation were also identified. As a result, the project aims to mitigate climate risks through sustainable FLR practices and tools combining geospatial information, with biophysical and climate data for ecological restoration – such as the Diversity4Restoration Tool,[37] which considers climate change when choosing appropriate species.

Climate adaptation options and benefits

Many of the GEF concept notes included a general definition of climate change adaptation benefits, referring to the overall environmental benefits. Some projects, such as the project in Burundi, included more specific definitions, such as including adaptation benefits related to flood risk management.

The project will increase the resilience of at least 120 000 people from the two Bujumbura provinces, Bujumbura Mairie and Bujumbura Rural. The project will restore 3 000 ha of degraded areas through tree planting, an additional 1 000 km of anti-erosion ditches and terraces and 1.5 km of flood control infrastructures along the Ntahangwa River in Bujumbura. Burundi GEF Project (GEF, 2020).

Clear connection between forest and landscape restoration and adaptation

Both the Burundi and regional Caribbean small island developing state (SIDS) (GEF, 2021b) projects also clearly defined the link between FLR implementation and adaptation benefits.

In Burundi, the project will promote ecosystem-based adaptation techniques with local communities in the highland upstream areas of the Ntahangwa watershed (including landscape restoration techniques (e.g. on planting trees and creating quickset hedges) and community-based anti-erosion measures) to reduce soil erosion, increase soil moisture and reduce surface water runoff. These techniques will help added protection against drought and heat waves on crops (GEF, 2020).

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[37] See www.diversityforrestoration.org/

In the regional Caribbean SIDS initiative, the multicountry project will address soil management for integrated landscape restoration and climate-resilient food systems. It aims to provide tools to adopt policies, measures and best practices, and support a review of the required legal and institutional frameworks to achieve LDN and climate resilience.

The review of the approved GEF-7 projects illustrate that all the documents (eight in total) include sophisticated and detailed climate screening, as well as clearly defined climate adaptation benefits and connection with FLR. The recent efforts in applying methodologies for climate-risk screening in FLR projects show positive results, particularly visible at the stage when the project is approved. At the stage of concept approval, most of the projects are requested to improve the description of climatic trends and provide climate projection data for temperature and rainfall in the target area. For example, the project will need to consider how a specific crop production will be influenced by changes in temperature and rainfall – and what adaptation, or transformations will be required as a result of key climate impacts on agricultural production and biodiversity. Having a clear causal pathway between climate impact to mitigation actions, in the development of projects at the conceptual stage would clearly highlight the adaptation benefits and identify climate risks to be managed in FLR projects.

Forest systems or landscapes targeted

Given the broad range of geographical regions in which FAO operates, it is unsurprising that FLR is realized across a diversity of ecological regions and wide-ranging species and ecosystems, including rainforest, dry and mesophilic forest, and coniferous and pine forests. Forest and landscape restoration is targeted based on the extent of degradation, exposure to climatic hazards, presence of endemic species, and the ecological and economic value of the forest. For example, the GEF Lebanon project "Smart adaptation of forest landscapes in mountain areas (SALMA)" focuses on FLR of cedar forests. Restoration activities are targeted according to the National Physical Master Plan for Lebanon which identifies conifer forests as the most vulnerable ecosystems. It also associates climate change-induced vulnerabilities such as fire and pest outbreaks for pine forest, pest outbreaks for cedar and juniper forests, and other threats such as habitat loss and reduced regeneration.

Scope of forest and landscape restoration

The key driver for FLR is the recognition of the environmental and socioeconomic importance of forests and forested landscapes, specifically for their provision of ecosystem services, their role in protecting against climatic stress and reducing disaster risks, and in response mechanisms for dealing with the effects of climate variability and change. Given their contribution to national GDP, the economic value and role of maintaining forest ecosystems are recognized. However, despite the diversity of forest ecosystems, landscapes and geographic regions, forest loss and land degradation continue to occur because of unsustainable and intensive land use. Uncontrolled rates of deforestation are fuelled by high demand for timber, fodder, construction materials and wood-based energy (charcoal and fuelwood for rural and urban markets), clearing for conversion to agriculture or artificial plantations, and overgrazing.

The impacts of deforestation are illustrated in the GCF Nepal project "Building a resilient Churia Region", where it is a major cause of land-use change that further accelerates climate vulnerability in upstream and downstream areas of the Churia Terai-Madhesh Region. Nearly 75 percent of deforestation and forest degradation in the project area occurred in the Churia hills, resulting in GHG emissions, soil erosion and downstream river sedimentation. The removal of vegetation on sloped areas increases the risk of landslides, while sedimentation further limits groundwater recharge and impacts water security, increasing the risk of flooding for many local communities.

Forest and landscape restoration interventions from the project target regions and rural communities already experiencing challenging climate change impacts. Restoration activities are considered to have numerous positive socioeconomic and environmental impacts. These include improved water security and availability, soil nutrition, biodiversity conservation, agricultural productivity and food security. Forest and landscape restoration activities are also expected to have adaptation and mitigation benefits for the region, such as increased ecosystem resilience from climate change impacts and reduced GHG emissions, as well as improved carbon sequestration (aim of 11.5 million tCO_2eq emissions avoided in targeted areas[38]).

The GCF Cuba project "Increased climate resilience of rural households and communities through the rehabilitation of production landscapes in selected localities (IRES)", targets forests and landscapes infested by marabú (*Dichrostachys cynerea*), an aggressive, non-native invasive woody bush species, which colonizes and dominates other plant species, damaging agricultural and pasture land. There is a direct, positive correlation between increased droughts and increased infestation in these areas. As a result, farmers are forced to abandon their lands for agricultural production.

Key ecosystem services associated with forest and landscape restoration interventions

Loss and degradation of forests and landscapes have resulted in the loss and decline of biodiversity and ecosystem services (Ciccarese, 2012). Restored forests and landscapes provide a range of ecosystem services that are vital to support adaptation to extreme climate events and incremental climate change. For example, watershed restoration can provide significant ecosystem services such as the regulation of water flow, improvement of water quality, increase of groundwater recharge and provision of riparian buffers. Development of agroforestry and silvopastoral systems, ANR and reforestation can, for example, also enrich biodiversity, improve livelihood opportunities, support soil fertility and increase carbon in soils and biomass, providing significant mitigation and adaptation benefits.

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[38] See www.greenclimate.fund/sites/default/files/document/funding-proposal-fp118-fao-nepal.pdf

Land use and forests also act as an important carbon sink. For example, as part of the GEF Democratic Republic of the Congo project "Community-based miombo forest management in South-East Katanga", carbon stocks held in 1 million ha of miombo forests in the Katanga charcoal supply zone were estimated to be 39 million t of carbon per ha. Forests allow the diversification of local livelihoods and food, for example, through the use of non-timber resources such as medicinal plant species, mushrooms, honey and termites for medical purposes, food and culture.

In Cuba, the rehabilitation of marabú-infested forests and landscapes through the GCF project IRES is expected to improve the resilience of ecosystem services. It is recognized that planted forests can reduce the effects of extreme climate events and higher temperatures. They contribute a greater volume of biomass (litter, branches, fruit, etc.) to the soil, which, when decomposed, constitutes a fundamental factor in the improvement of the hydrophysical properties of the soil (structure and porosity, among others). In addition, the root systems of planted forests are deeper and more expansive, supporting improved groundwater filtration to lower levels, therefore influencing infiltration and soil moisture retention capacity.

Key incentives for restoration

The process of FLR can work to improve both economic and ecological resilience to the impacts of climate change. The FAO flagship projects reviewed identified that without the off-farm restoration activities, under climate change, small-scale farmers would face increasing environmental challenges, such as soil erosion and water insecurity, which would eventually render their livelihoods unsustainable regardless of the success of the investments in their food production systems. Forest and landscape restoration is also often associated with the diversification of livelihood assets and income sources, direct adaptation benefits and formalization of land tenure to promote long-term investments as well as set the basis for PES schemes.

In Paraguay, the generation of additional annual income, as a result of improved forestry management through the GCF project "Poverty, reforestation, energy and climate change (PROEZA)", increased the sale of sustainably sourced firewood, agroforestry products, timber and NTFPs. This constitutes a significant incentive for restoration. The project is designed to establish multifunctional close-to-nature planted forests to enable households to become energy self-sufficient and allow them to offer firewood surplus to local or regional bioenergy markets. Such forests also serve as savings accounts for poor rural families, who can cut and sell individual valuable trees when there is an unforeseen expenditure. In the Sudan, the GCF project "Gums for adaptation and mitigation in the Sudan" (GCF, 2020) illustrates how the restoration of smallholder gum agroforestry systems along with the reforestation of degraded land can be more profitable and resilient. The project aims to enhance the adaptive capacity of local communities and restore the carbon sink potential of the gum arabic belt, expanding Africa's Great Green Wall. These smallholder gum systems produce sizeable quantities of clean, dry gum (gum trees are by far the most resilient crop with regards to tolerating increasing moisture stress in the project area). Greater community participation (e.g. Lebanon) and awareness of forest ecosystem services among government agencies, and central and local administration are also considered crucial to enable the successful implementation of restoration on the ground.

Approaches for implementing the forest and landscape restoration practices

Participatory and community-driven approaches to forest management that are informed by site-specific vulnerability and risk assessments of vulnerable forest stands are important factors to consider in achieving adaptation benefits through FLR. Local community forest concession titles are often granted to transfer the rights and responsibilities of forests management to local communities. For example, in the GEF Democratic Republic of the Congo project "Community-based miombo forest management in South-East Katanga", local community forest concessions and the transfer of rights and responsibilities of forests management to local communities will cover up to a maximum of 334 656 ha.

Community co-management of forests has proven to be a successful strategy to ensure the sustainability of rehabilitation efforts, generating shared responsibility and accountability to protect forests for community use. For this reason, FAO often supports the establishment of local-level forest management groups and the development of participatory land-use plans for the co-management of rehabilitated woodlands. The Village Cluster Level Adaptation Planning exercise in the Sudan (initiated by the International Fund for Agricultural Development (IFAD) and carried forward by FAO) prioritized gum agroforestry restoration investments as the main adaptation response to protect the agriculture production systems and livelihoods against increased climatic stress. Participatory management of forests and land is accompanied by capacity building and institutional support for FLR at both national and local levels. It also trains forest management members and groups to take an active role in tree planting and forest restoration (e.g. managing tree nurseries and protecting common forest resources), and has set up community tree nurseries (fruit trees and valuable trees for the communities, in particular). To ensure successful adoption and replication of FLR techniques and relevant governance, FAO encourages coordination between sectors and ministries such as finance and law enforcement, to support entities regulating forest, land use, environment and agriculture.

Expected impact of forest and landscape restoration in terms of adaptation

The overall objective of FLR is to restore degraded landscapes to a healthy and productive state to fulfil the needs of both the people and the environment in a sustainable way. The adaptation results of restoration are associated with ecosystem services provided by the forests. These include the regulation of microclimate, retention of soil moisture to counteract increases in evaporation, infiltration of runoff, preservation of aquifer recharge and stream flow stabilization to enhance resilience to rainfall variability, increases in temperature, drought and extreme weather events. Reforestation and reduction of land degradation can therefore enhance the resilience of vulnerable rural communities, and address the lack of response mechanisms to extreme weather events at central and local levels.

For example, in the GCF Cuba project IRES, marabú infestation is primarily caused by severe droughts. It significantly impacts agricultural and livestock production, causing farmers to abandon their lands and impacting community food security. The restoration of marabú-infested lands, in Las Tunas and the Villa Clara/Matanzas provinces, is expected to improve the resilience of critical ecosystems and ecosystem services. Forest planting aims to buffer the effects of extreme climate events and higher temperatures. The restoration of farmland from marabú thickets through agroforestry, closed-to-nature planted forests and ANR, together with the restoration of rangeland through silvopastoral systems, is performed to provide improved and more stable crop yields and enhanced health, well-being and livelihoods for communities in the target regions. The FLR interventions expect to improve the resilience of approximately 30 percent of the total population in the climate-vulnerable areas of Las Tunas and Villa Clara/Matanzas provinces.

Long-term financial strategy for the restoration practices

Forest and landscape restoration is considered economically viable when it includes sustainability measures that enable a direct, positive economic impact at household and community level (e.g. through livelihood and income diversification and strengthening). The combination of technical assistance and ecological restoration is expected to create positive economic impacts, increasing the productivity, resilience and economic viability of agricultural systems. There are diverse sustainable financing mechanisms developed through FLR. For example, the development of alternative livelihood opportunities (sustainable harvesting of timber and NTFPs), the establishment of community forest management funds, which have the function of collecting and redistributing income generated by forest products harvested from forest user groups, and the establishment of PES schemes as a reward for the implementation of sustainable and restorative land management practices.

Often, there is a perception that an increased and reliable income stream from more climate-resilient crop and livestock systems and forest products, and stronger farmers´ organizations, enable small-scale farmers to secure adequate finance to meet livelihood needs and continuously invest in adaptation measures to keep pace with the rate of climate change. For example, the Sudan GCF project "Gums for adaptation and mitigation in the Sudan: Enhancing adaptive capacity of local communities and restoring the carbon sink potential of the gum arabic belt, expanding Africa's Great Green Wall" is expected to build the capacity of farmers to continue to leverage the purchase guarantees of the gum exporters mobilized by the project to obtain formal financial services from microfinance institutions, including from Ebda'a Microfinance Bank. This bank has already committed to providing credit for smallholder gum producers in partnership with the project, using the exporting companies' purchase guarantees as collateral. The economic benefits will provide a strong incentive, inducing beneficiaries to continue to invest in and maintain the restored landscapes, therefore establishing a reward cycle of adaptation and carbon sequestration through poverty reduction. In addition, in the AF project "Enhancing livelihood resilience in Vanuatu through forest and landscape restoration", community-based financial management plans are anticipated to safeguard ownership and long-term financial sustainability of the restoration activities (see Box 4).

Seizing opportunities to finance forest and landscape restoration

The review identified common trends towards continuing the financing of FLR initiatives beyond project closure. This may be conducted through, for example, PES schemes, partial allocation of revenue from the exploitation of forest resources and from public finance, including taxes. The GEF Pakistan project "Reversing deforestation and degradation in high conservation value chilgoza pine forests", is designed to support the development of institutions, policies and regulations to enable the use of PES for the implementation of restoration activities. The GEF Democratic Republic of the Congo project "Community-based miombo forest management in South-East Katanga" also supports a public financing mechanism. Provincial-level fiscal measures dedicate a portion of revenues from forest product (and other) taxes to finance the replication and adaptation of the sustainable community forest management approach throughout the province. The miombo community forest management model is also a self-financing participatory natural forest management system for the commercial production of wood products. The project promotes the principle that each commercial forest user group should contribute proportionately to forest management costs, thought the forest management funds. A portion of revenues from the sale of charcoal and other products is invested back into community-controlled management funds to cover forest management costs.

Box 4

Vanuatu Adaptation Fund

The project "Enhancing livelihood resilience in Vanuatu through forest and landscape restoration" aims to improve resilience and food security through ecosystem-based adaptation measures. Through the FLR approach, the project aims to i) enhance the enabling environment to improve disaster risk governance, response and recovery; ii) support climate-resilient forest and land resource management to protect coastal and inland ecosystem and productive assets; and, iii) improve sustainable forestry to increase adaptive capacity and reduce the vulnerability of communities.

A Pacific SIDS, Vanuatu is increasingly exposed to natural disasters due to its geographic position within the volcanic arc and cyclonic area. Climate change impacts from frequent and devastating natural disasters such as cyclones, increased flood and drought intensity, sea level rise, temperature increases, changes in rainfall patterns and other extreme events threaten 80 percent of inhabitants reliant on natural resources.

To mitigate climate change and increase its adaptation potential, Vanuatu is developing an ambitious FLR strategy. The project supports Vanuatu's "efforts in adapting to climate change through the promotion of FLR". Specifically, this aims to "bring relevant stakeholders together to identify and implement practices to restore an agreed optimal balance of the ecological, social and economic benefits of forests within a broader pattern of land uses".

FAO has supported the Ministry of Climate Change Adaptation, Meteorology, Geo-Hazards, Environment, Energy and Disaster Management in Vanuatu to develop a project concept note for the AF, which was approved in October 2021 for USD 7 128 450. The project will support the implementation of adaptation activities to reduce adverse impacts of, and risks, posed by climate change in Vanuatu.

Some of these sustainable finance models are anticipated to become a reference for future forest reforestation and restoration initiatives. For example, the GEF Lebanon project SALMA, is implementing cost-effective, relevant (restoration and reforestation plans are identified together with the targeted communities, while also aligned with the National Physical Master Plan of the Lebanese Territory) and informed (scientific knowledge and technology made available) guidance and processes for reforestation and forest management resilient to climate change. The focus is on reducing pest outbreaks and forest fires, and protecting the cedar corridor to reduce fragmentation of cedar groves and increase the cedar climate resilience by increasing the gene flow among the isolated populations.

Role of the government and other stakeholders in forest and landscape restoration

Government agencies responsible for forestry, agriculture and environment often play a key role leading the design and implementation of relevant policies, law enforcement and regulation on forest and natural resources management in response to evolving conditions and pressures resulting from climate change, as well as in the collection and dissemination of climatic information in support of medium- and long-term adaptation planning. Their role is also essential in the coordination and execution of programmes for the conservation, development, use and sustainable management of forests (e.g. provision of technical advice, procurement of external inputs, seedlings, mechanical soil preparation on degraded lands) across different sections and provinces and between diverse stakeholders. Other key stakeholders in FLR include local cooperatives and producer associations, entrepreneurship groups, community forest management groups, community institutions, and Indigenous Peoples.

In the GEF El Salvador project "Climate change adaptation to reduce land degradation in fragile microwatersheds located in the municipalities of Texistepeque and Candelaria de la Frontera", the General Directorate of Forestry, River Basins and Irrigation Management, its Climate Change Division and the National Centre of Agriculture, Livestock and Forestry Technology lead the participatory watershed

Community tree nursery, South Kivu, Democratic Republic of the Congo

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planning, definition of mechanisms for community-based monitoring systems, tracking of progress towards reforestation and assessment of water quality and quantity. Under national environmental law, local governments from the municipalities of Texistepeque and Candelaria de la Frontera are responsible for integrating the principles of conservation, development and sustainable use of natural resources in local planning processes. Municipalities can formulate local environmental policies in consultation with communities and may issue local ordinances or other legal instruments within the framework of the Constitution. The Municipal Environmental Unit could, as a result of institutional strengthening, serve as outreach agents for climate change agriculture and FLR activities initiated by the project.

Provincial and regional departments have a stake in guiding FLR in the field to ensure interagency coordination for SFM at the provincial level and the development of forestry management plans. For example, in the GEF Burundi Project "Natural landscapes rehabilitation and climate change adaptation in the region of Mumirwa in Bujumbura and Mayor of Bujumbura through a farmer field school approach", the Department of Forestry will be closely involved in the management and service provision of activities associated with the reforestation of 5 000 ha of degraded woodland through SFM. As direct beneficiaries of the project, farmer communities also play a key role and will be actively involved in the restoration interventions through farmer field schools and community tree nurseries.

There are several critical barriers for FLR investments to support climate change mitigation and adaptation outcomes. These include, but are not limited to, a lack of awareness and technical capacities of government staff at all levels in respect of sustainable and resilient agroforestry, community forest management, landscape rehabilitation and land planning; a lack of relevant and cross-sectoral policies on landscape use and forest management; and the weak application of legal instruments, including regarding FLR.

A remaining major constraint to adaptive forest management is the weak intersectoral horizontal and vertical coordination at the local and provincial levels among key players involved in forest-related activities. Different sectors (e.g. forestry, agriculture, grazing and water) either compete, or have contradictory aims, leading to uncoordinated planning and actions. Consequently, government actions and investments that aim to strengthen the resilience of forest ecosystems occur with limited regard to their impact at landscape level.

This is also a result of the prioritization of other interventions over FLR and insufficient government resources for large-scale investments in the restoration of ecosystems. Furthermore, it is recognized that smallholders have limited financial capacity to invest in the infrastructure, equipment and inputs required for FLR and adaptation of their agroecosystems. They also have limited awareness of the ecosystem services provided by the forests and of climate change-induced impacts to livelihoods and the environment, and they lack technical capacity regarding the availability and application of agroecosystem management options for adapting to climate change, and alternative approaches to restoration.

The GCF Lebanon project SALMA carried out a detailed assessment of the critical barriers for FLR investments at local level. It recognized that farmers have access to a limited range of genetic material, resulting in reduced resilience to climate change and variability. Since active restoration typically requires significant investment in the establishment of nurseries and purchase of seed and nursery equipment, inadequate financing and organizational difficulties also limited their ability to restore ecosystem goods and services in the wider landscape.

Monitoring strategies for forest and landscape restoration practices

Remote sensing, geospatial analysis and GIS-based monitoring and evaluating systems are an efficient way to monitor, measure and assess the impact of reforestation and SFM activities. This is particularly apparent when used to improve and complement existing national forest monitoring systems. Innovative tools such as FAO's Collect Earth[39] can support the analysis of high- and very high-resolution satellite imagery. They can also help set land-use baselines and quantify deforestation, reforestation and desertification at plot and landscape levels. The combination of remote-sensing analysis, ground truthing and participatory monitoring involving local institutions and communities is expected to create a verifiable assessment of FLR's effectiveness and efficiency.

For example, the GCF Nepal project "Building a resilient Churia Region" is monitoring restoration interventions with the establishment and operationalization of a Churia Knowledge Centre in each province. These centres will have a specific mandate to deliver climate-informed extension services and planning, as well as monitor implementation and results of the Critical Ecosystem Restoration Plans, developed for each of the 26 targeted river systems. These plans are conceptualized to enable evidence-based planning and monitoring of FLR interventions, while also providing governments with a guide to prioritizing and coordinating investments in climate-resilient natural resource management.

Lessons learned from the long history of investment in FLR at country and regional levels (e.g. GEF, the Sanibel-Captiva Conservation Foundation (SCCF) and REDD+) through FAO and co-executing partners (e.g. other IFIs and multilateral organizations) suggest that FAO and its partner institutions have sufficient local presence, technical capacity and practical experience on diversifying land and agroecosystem management practices to sustain and enhance the provision of ecosystem services, including productivity and livelihoods, while addressing land degradation, biodiversity and climate change related issues.

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[39] See www.fao.org/land-water/land/land-governance/land-resources-planning-toolbox/category/details/en/c/1026549/

The governance structures established during the implementation of previous FAO-supported projects, especially those for adaptation, landscape restoration and territorial planning, are a strong foundation for the most recent projects. FAO has always guaranteed the involvement of the decision-makers from partner institutions to local communities, to ensure process sustainability. In El Salvador, a key lesson is that communities are aware of the challenges that affect them and their causes, but do not know how to overcome inertia and initiate actions to correct them. Training on FLR is only effective when it is framed within practical ongoing actions, allowing knowledge to be used immediately. Gender issues must be considered from the initial design phase and throughout the project implementation to develop and enable gender-responsive restoration.

The plans and actions of extension agents must reflect those of the beneficiary communities, and the technologies promoted should be adjusted to the biophysical and socioeconomic reality of the producers on the ground. In Pakistan, a key success factor for ANR by the "Billion tree tsunami afforestation" project was the establishment of watershed management committees. These had key roles in priority setting and implementation of the project activities.

A similar review of participatory forest management across Africa (Blomley, 2013), has demonstrated that FLR, implemented through community forestry, is most successful where community empowerment is strongest. In particular where: i) simple and practical procedures and guidelines for legalization of community tenure rights; ii) the local community definition of forest management areas; iii) legally recognized community-level management entities; iv) the establishment of community forest management rules governing access and use; and, v) the inclusion of marginalized groups that hold a stake in the resource were considered. Effective community-level institutions are also required to develop and implement rules governing access and use of forest resources, and to ensure that costs and benefits of forest management are shared equitably among local forest users. Community institutions are most effective when built on existing structures or when communities are given strong leeway in defining them. It is therefore important to carefully consider vertical (upward, as well as downward) accountability mechanisms, appropriate scale and linkages to existing formal and traditional structures.

The Burundi portfolio has illustrated the importance of knowledge and innovation through land diagnostics and assessment to guide project interventions. The scaling-up of specific FLR practices should be informed and guided by the mapping of land degradation (types, extent, severity and trend, as well as drivers, pressures and impacts) and ongoing practices (type, extent and effectiveness on the ground). The most successful sustainable mechanisms are also linked to the creation of community-controlled forest management funds.

Participatory forest management is often established as a commercial enterprise, which, through the payment of taxes and various mechanisms for reinvesting a portion of forest revenues back into the funding of forest management costs, generates benefits for community members and the community as a whole. Attempts to legislate protection of forests, including by making charcoal illegal, often do not work, unless an alternative is identified to produce wood fuels. For example, charcoal production from natural miombo forests in Malawi has always been illegal, and the country has lost 90 percent of their miombo forests and lacks a sustainable natural forest management system to produce wood fuels.

5. Boosting forest and landscape restoration through global frameworks and initiatives: opportunities for climate action

There are many opportunities for FLR to support climate change mitigation and adaptation outcomes. Forest and landscape restoration has gained importance in several global frameworks and initiatives, such as the UNFCCC, CBD and UNCCD, as highlighted with the United Nations Decade on Ecosystem Restoration (2021–2030). Key aspects on the challenges to and successful outcomes of implementing FLR for climate resilience have emerged, but are clearly context specific given the varying temporal scale, size and purpose of FLR activities and objectives. Lessons learned from experience on climate issues related to FLR highlighted key issues to address and consider. They also illustrated the need to incorporate future climate projects and develop financial and technical innovations that can support adaptive capacity for actors implementing FLR on the ground.

5.1. Reducing emissions from deforestation and forest degradation in developing countries (REDD+)

Climate change initiatives such as REDD+ have boosted the FLR approach and implementation of projects on the ground. The IPCC recognizes the potential for REDD+ to significantly reduce AFOLU emissions by slowing, halting and reversing the drivers for deforestation and land degradation. Activities under REDD+, supported by climate change frameworks, have the potential to boost restoration outcomes and increase the long-term resilience of ecosystems and communities to further climate change impacts.

The UN-REDD Programme has supported country partners since 2008 in their "readiness" to qualify for results-based payments (Box 5). Other initiatives implementing REDD+ strategies include: i) the Central African Forest Initiative (CAFI)[40] (a collaboration of UNDP, FAO, the World Bank, six Central African countries and a coalition of donors), which aims to support national governments implement reforms and enhance investments to halt drivers of tropical deforestation; ii) the REDD Plus Partnership;[41] iii) the Forest Carbon Partnership Facility (FCPF);[42] iv) the EU REDD Facility;[43] and, v) the UN-REDD Programme.[44]

Box 5

UN-REDD Programme in Chile

Chile has been working to reduce emissions from deforestation and enhance forest carbon stocks (REDD+) since 2010. The Ministry of Agriculture (MINAGRI) has promoted the National Strategy on Climate Change and Vegetation Resources (Estrategio Nacional de Cambio Climático y Recursos Vegetacionales) to support efforts for climate change mitigation and adaptation in partnership with FAO, UNDP and UNEP (UN-REDD Programme partners). Chile aims to implement different forest management models, including ecological restoration in native forests affected by forest fires or invasive species.

Two models have been piloted in Tierra del Fuego, Magellan Region, and have involved the repopulation of 22 000 seedlings of native forest species across 27 ha to address degradation from introduced beaver populations. An ambitious goal to scale up restoration to more than 23 000 ha is in place. Another pilot in Malleco National Reserve and Tolhuaca National Park, Araucanía Region has been implemented to address the impact of forest fires in 2015. This involved reforestation of 50 ha of 14 000 seedlings of native tree species, and watershed protection including fencing to protect the seedlings. The second stage of the project aims to reforest 150 ha of additional land with 500 000 seedlings, with the involvement of Indigenous and local communities.

These pilots have used a repopulation strategy that can be upscaled and which supports enhanced stakeholder engagement. This will also help Chile meet climate change and biodiversity commitments, including those in its NDC.

Sources: FAO. 2021. The National Forest Monitoring System as part of the National Strategy on Climate Change and Vegetation Resources in Chile. Rome. www.fao.org/publications/card/fr/c/CB4253EN/

UN-REDD Programme. 2020. Ecological restoration as a tool for adapting and mitigating the impacts of climate change. In: UN-REDD Programme. 18 September 2020. Cited August 2022. www.un-redd.org/news/ecological-restoration-tool-adapting-and-mitigating-impacts-climate-change

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[40] See www.cafi.org/welcome

[41] See www.reddpluspartnership.org/en/

[42] See www.forestcarbonpartnership.org/

[43] See www.euredd.efi.int/

[44] See www.un-redd.org/

5.2. Land tenure and Indigenous Peoples

Key to the implementation of FLR projects that support climate change agendas is enabling secure land tenure. Unclear and insecure land tenure of forested lands presents a key barrier for Indigenous Peoples and organizations to initiating and delivering restoration and sustainable land-use practices that can also support climate adaptation and mitigation (IPCC, 2019). Limited or no recognition of customary land ownership and access can lead to conflicts, increase vulnerability and decrease the adaptive capacity of Indigenous Peoples and ecosystems. The impacts of climate change require a flexible policy response to land tenure issues.

There is a strong correlation between secure collective tenure and reduced deforestation and land degradation (FAO and FILAC, 2021). Tenure rights and security influence the willingness of landholders to engage with and invest in restoration activities (McLain *et al.*, 2018). To improve the incentive to restore forests and landscapes, and support climate cobenefits, these rights must be identified. Significant areas of forest (and carbon stocks) are managed by Indigenous Peoples – approximately 24 percent (54 546 million t of carbon) of the total above-ground carbon stored in tropical forests (FAO and FILAC, 2021; RRI, 2018) – therefore their rights and role in the protection and restoration of forests and landscapes to support climate change mitigation and adaptation must be clearly recognized. The securing of land tenure rights has been highlighted as a key enabling condition for successful REDD+ outcomes, including enhancing access to investors (Sunderlin *et al.*, 2018; Bradley and Fortuna, 2021). Initiatives such as the Forest and Farm Facility (FFF)[45] have also emphasized that one of the most effective methods of reducing deforestation and strengthening social and environmental climate resilience is to secure the rights of Indigenous Peoples.

The FLR approach to enable and strengthen participation of all stakeholders in restoration is further supported by CBD (Decision CBD/COP/14/5[46]), the UNFCCC Indigenous Peoples' Platform[47] to strengthen participation of Indigenous Peoples, and the COP26 IPLC Forest Tenure Joint Donor Statement,[48] which also pledged USD 1.7 billion of financing from 2021–2025 to support the forest tenure rights of Indigenous People and local communities. Their engagement and participation support addressing of legal tenure in FLR. It should be noted, however, that tenure, even when legally granted, may be further constrained by the wider social, political and legal context of the project area (de Jong *et al.*, 2018). Tenure may therefore vary across landscapes, and political and sociocultural governance systems. Identifying, securing and, in some cases, supporting increased tenure in the context of restoration sites is therefore important to consider to support successful restoration and climate change outcomes (McLain *et al.*, 2018). Tools such as the Restoration Opportunities Assessment Methodology (ROAM) can be used to identify institutional and policy arrangements in place related to land tenure (IUCN and WRI, 2014).

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[45] FFF, a partnership between FAO, the International Institute for Environment and Development (IIED), IUCN and AGricord, works to support efforts by farmers, community forest and rural women's groups, and Indigenous Peoples' organizations to address climate change and improve rural livelihoods (for more information, see www.fao.org/forest-farm-facility/about/en).

[46] See www.cbd.int/doc/decisions/cop-14/cop-14-dec-05-en.pdf

[47] See https://unfccc.int/LCIPP

[48] See https://ukcop26.org/cop26-iplc-forest-tenure-joint-donor-statement

5.3. Forest and landscape restoration finance

Economic incentives for restoration activities and sustainable land-use must outweigh those that drive deforestation and landscape degradation. The recent review by Dasgupta (2021) highlighted the economic impact of markets and institutions failing to recognize and integrate the true value of ecosystems and their services into decision-making. Public good ecosystem services are often used unsustainably, driving economic and societal demand for ecosystem services that far exceeds their provision, further driving degradation (UNEP, 2021a). Financing and harnessing the potential of restoration solutions to build climate-resilient landscapes require the real value of intact forest ecosystem goods and services to be recognized and integrated into policy responses and financial investments.

Restoration at the scale needed to meet ambitious global targets requires significant public and private investment. It is estimated that to meet these targets, USD 36-49 billion per year is needed (FAO and Global Mechanism of the UNCCD, 2015). The need to unlock additional finance to protect, restore and sustainably manage forests is essential to meet the goals of the Paris Agreement, as recognized by the United Nations Decade and UNFCCC COP26 pledges.

There is increasing evidence to show that restored ecosystems are more profitable than the costs of implementing restoration (UNEP, 2021a). Ding *et al.* (2018) suggest that USD 30 of economic benefits are created for every USD 1 invested in restoration. For example, following forest restoration that more than doubled forest cover in Costa Rica since 1980, income from ecotourism now accounts for 6 percent of the country's GDP. The Economics of Ecosystem Restoration[49] multipartner initiative led by FAO is collecting standardized data on the costs and benefits of ecosystem restoration. This aims to support decision-makers in better targeting restoration initiatives and mobilizing appropriate and accessible finance for both restoration, and climate change mitigation and adaptation outcomes. Investors can also benefit from the cost–benefit analysis of restoration to support their own financing strategies and meet their risk mitigation and returns of investment criteria.

Local or national governments and organizations may, however, be limited in their financial capacity to support FLR activities. To upscale FLR implementation and leverage additional investment, markets and supportive enabling environments and policy frameworks will be key (Brancalion and Chazdon, 2017). Mechanisms that provide conservation, restoration and carbon values through offsets and reward-based payments should also be considered. Others, such as innovative blended financial instruments of private impact funds that benefit from public investments can aggregate funds and spread the burden of risk. Establishing mechanisms that mitigate investment risk against the rate of returns can also improve the engagement of private investors at the scale needed (FAO and Global Mechanism of the UNCCD, 2015). Policies are also needed to realign adverse investments that drive degradation and further climate change (Löfgvist and Ghazoul, 2019), and integrate the diverse landscape and stakeholder needs to support restoration and climate action outcomes.

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[49] See www.fao.org/in-action/forest-landscape-restoration-mechanism/our-work/gl/teer/en/

Since 2017, annual international finance from developed countries has mobilized more than USD 70 billion. However, COP26 highlighted the lack of representation of Indigenous Peoples in international funding processes, and the need to ensure their status as accredited conduits and recipients of large-scale climate finance, such as GCF, GEF and bilateral aid (MacQueen, 2021). Local-level investment in FLR is vital to build climate resilience (MacQueen, 2021; Besacier *et al.*, 2020. The use of existing institutions and organizations to channel finance presents a potential avenue for channelling larger-scale climate finance to restoration activities on the ground. For example, the FFF can provide direct financial support to local farmers' or forest smallholders' organizations to improve the sustainability of their production and land management. Many of these activities will also have positive cobenefits in supporting climate resilience, which are economic, sociocultural, technological and ecological (MacQueen, 2021).

Further financial pledges were made at COP26 to support the restoration of forests and landscapes in meeting climate change targets. The COP26 Global Forest Finance Pledge committed USD 12 billion for forest-related climate finance between 2021 and 2025 to support the protection, restoration and sustainable management of forests and address the systemic drivers of forest loss. The COP26 Congo Basin Joint Donor Statement[50] made an initial pledge of USD 1.5 billion of financing between 2021 and 2025 to support the protection and sustainable management of the Congo Basin forests, peatlands and other critical global carbon stores.

Restoration investments can also create livelihood opportunities for building the social resilience of communities and adapting to climate change, as for example, with the Great Green Wall for the Sahara and the Sahel Initiative.[51] Launched in 2007 by the African Union, the Great Green Wall aims to restore 100 million ha of degraded land, sequester 250 million t of carbon and create 10 million green jobs by 2030. It operates across 11 countries in the semi-arid Sahel region, with the overall objective of combating climate change and desertification, and addressing food insecurity and poverty by enabling a mosaic of sustainable land-use practices and the restoration of vegetation. It is the first Flagship Initiative of the United Nations Decade on Ecosystem Restoration (UNEP, 2021b). Many restoration programmes operate within the GGW initiative, funded by GEF and other donors such as the French Facility for Global Environment (FFEM) and IKI. FAO, in collaboration with the GGW national and pan-African agencies, and other partners, is also supporting the development of the project "Scaling-up resilience in Africa's Great Green Wall". This is a 10-year GCF programme of USD 226.5 million to restore 2 million ha in eight countries of the Great Green Wall. These large-scale investments and initiatives hope to restore a diversity of drylands, soils and forests, protect biodiversity and improve land and water management practices. This will support local stakeholders in building their resilience and adaptive capacity to climate change, and generating benefits greater than the original investment (UNEP, 2021a).

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[50] See https://ukcop26.org/cop26-congo-basin-joint-donor-statement/

[51] See www.unccd.int/our-work/ggwi

Innovative finance is key for restoration and sustainable landscape management to support climate action. The FLR approach can help target climate finance and advocate for restoration-aligned opportunities in climate change instruments, such as the AF and GCF. Engagement with the private sector will be essential for scaling up restoration and climate-proofing value chains through the development of sustainable production and markets. The integrated nature of FLR can support the development of mechanisms such as green bonds and blended finance to incentivize the private sector to invest and avoid further forest and landscape degradation (Louman *et al.*, 2020).

5.4. Carbon markets

Policy instruments such as investment of carbon taxes into nature-based solutions have been widely promoted as a policy mechanism for providing incentives for landholders to restore and protect their lands. Global demand for voluntary carbon credits has increased dramatically in recent years, with the total value of the market tracked at USD 473 million in 2020 and USD 6.7 billion in 2021 (Forest Trends' Ecosystem Marketplace, 2021). Despite high potential to unlock additional revenue and support climate change mitigation, they still only cover about 0.2 percent of global GHG emissions.

There are also challenges with ensuring the environmental integrity of forest carbon credits. These include demonstrating additionality, setting accurate baselines, minimizing the risk of leakage, transparently assessing uncertainties and avoiding reversals. These challenges have been addressed through the development of standards at project and jurisdictional scales (Chagas *et al.*, 2020), but are still contested, especially in discussions related to offsetting.

Policy frameworks that support voluntary carbon markets can leverage additional revenue from carbon credits for the implementation of restoration (Slobodian *et al.*, 2020). For example, there is increasing demand for credits from jurisdictional programmes to protect and restore forests. Notably, the Lowering Emissions by Accelerating Forest finance (LEAF) Coalition mobilized USD 1 billion of public and private funding to incentivize large-scale tropical forest protection to be used for a combination of results-based payments and carbon credit purchases. The REDD+ Environmental Excellence Standard (TREES) under the Architecture for REDD+ Transactions (ART), which forms the basis for forest carbon crediting under LEAF, includes options for enhancing carbon removals from reforestation and forest restoration activities.

In coming years, additional demand for forest carbon credits is expected for compliance purposes. This includes those under the International Civil Aviation Organization Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and Article 6 rules that enable international voluntary cooperation for climate change mitigation. Article 6 relates to carbon markets and how emissions reductions under NDCs can and should be accounted for. In the Glasgow Climate Pact, Article 6 stated that carbon offsetting should rely on "real, verified and additional" emissions reductions, and aims to strengthen the market, providing greater certainty to the private sector that their investments are contributing to efforts to reaching net zero. It is yet unclear how countries will participate in Article 6 given the requirement for corresponding adjustments.

5.5. Possible role of forest and landscape restoration in enhancing nationally determined contributions, national adaptation programmes of action and national adaptation plans

Mainstreaming FLR actions into the NDCs is one of the challenges of achieving global climate goals (Crumpler *et al.* 2019; IUCN, 2020b; WRI, 2018). The integration of global FLR initiatives and their restoration commitments with tangible targets and indicators into NDCs, NAPAs and NAPs has the potential to foster synergies and better coordination across intersectoral plans and policies. For example, the adaptation aspect of FLR could also be aligned with NAPs[52] and NAPAs[53] to ensure intersectoral synergies and coordination. Linking NDCs with the existing quantitative restoration commitments under several global and regional initiatives that promote ecosystem restoration (e.g. Bonn Challenge, United Nations Decade on Ecosystem Restoration, REDD+ framework, AFR100, Initiative 20 x 20 and ECCA 20) can also add tangible and measurable targets in the NDCs, boosting climate change mitigation and adaptation outcomes.

Together with aligning international frameworks, adequate training and capacity building at a national level is also needed so that national officers are equipped to communicate and report the NDCs. Many developing countries require support in collecting data, and assessing and analysing climate impacts due to capacity and resource constraints. This is particularly challenging in the agricultural sectors, as the calculation methods of GHG emissions and removals, and the assessment of vulnerabilities, adaptive capacities, damage and loss are complex and depend on uncertainties related to the future impacts of climate change and data availability (i.e. land-use data, forest inventories, etc.).

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[52] The national adaptation plan (NAP) process was established under the Cancun Adaptation Framework 2010 to enable parties to plan to identify medium- and long-term adaptation needs, and develop and implement strategies to address those needs.

[53] National adaptation programmes of action (NAPAs) to support the least developed countries work programme (established under UNFCCC in 2001) address challenges posed by climate change.

FAO assists countries with the reporting requirements under the Paris Agreement and assessing GHG emissions and removals (see Box 6). This is conducted through various programmes, including the UN-REDD Programme, and with the provision of capacity building through various networks, tools and knowledge materials. The FAO and GEF project "Building global capacity to increase transparency in the forest sector (CBIT-Forest)" (FAO, 2020c) also aims to strengthen the institutional and technical capacities of developing countries in meeting the Enhanced Transparency Framework requirements of the Paris Agreement to track progress in implementing and achieving country NDCs. This support helps lower the level of uncertainty and ambiguity of current NDCs, improve transparency through the Enhanced Transparency Framework and set more ambitious climate commitments with tangible, robust and measurable targets in the AFOLU sector.

An increase in finance for FLR measures would also reinforce the achievement of NDCs. The vast majority of the FLR-related targets in the NDCs are conditional (IUCN, 2020b), meaning that they will only be achieved with financial or technical assistance, or both. Among the 130 submitted NDCs, only 53.6 million tCO2eq will be sequestrated unconditionally, while 3.2 billion tCO2eq will be sequestrated through FLR measures with conditional support (Crumpler *et al.*, 2021; IUCN, 2020b). In this context, linking FLR activities with climate finance mechanisms, such as GCF, GEF and the NDC Partnership is crucial to realize the conditional targets and scale up the implementation. Further efforts should be made to integrate the restoration and conservation of ecosystems with high carbon potential, such as peatlands, into national climate action and contributions. This can support cost-effective climate actions at the national level.

5.6. Conservation and links to biodiversity

The holistic approach of FLR aims to achieve not only restored, functional landscapes, but also sustainable food production, the provision of ecosystem services and biodiversity conservation. According to Beatty, Cox and Kuzee (2018), "biodiversity is inherent in forest and landscape restoration." UNEP (2021a) states that 60 percent of expected species extinctions could be avoided if just 15 percent of converted lands were restored, and further conversion of ecosystems was stopped. "Restoring forward" to include biodiversity conservation and protection can therefore ensure current and future biodiversity is maintained for resilient ecosystems and climate change adaptation (Beatty, Cox and Kuzee, 2018).

Carbon has a greater value if it remains in the ground. Adaptive management that prioritizes ecosystems with high carbon sinks, which, if lost, could not be recovered in time to meet 2050 climate goals can support efforts to reduce risk of increased GHG

Box 6

FAO support to country nationally determined contributions – Morocco and Lebanon

Through the FLRM, FAO leads the implementation of the project "The Paris Agreement in action" funded by IKI of the German Ministry of the Environment to support five countries (Ethiopia, Fiji, Lebanon, Morocco, the Niger and the Philippines) with expanding forest stocks and improving their ecosystem services in fulfilment of the Paris Agreement.

Morocco

In Morocco, the project has contributed to its NDC, with a focus of the FLR component on climate change adaptation and mitigation. It makes a clear linkage with the restoration of ecosystems, including biological diversity, integrated management of water resources, as well as sustainable land management to counter desertification and soil degradation throughout its territory.

Through capacity building activities supported by the project, national climate policy frameworks and workplans, including NDCs, have been developed. The country's revised NDC submitted in June 2021, indicates that the country aims to restore or rehabilitate degraded ecosystems on 50 000 ha per year, which contributes to a reduction of 6 613.4 Gt CO2 over 2020–2030, which sees a significant raised ambition than the previous NDC submitted in 2016. The revised NDC aims to reduce GHG emissions by 45.5 percent by 2030 against the business-as-usual scenario.

Lebanon

The project also supported the implementation of FLR programmes in Lebanon. Currently 13 percent of land is covered by forests. The project aims to increase forest coverage from 13 percent to 20 percent by promoting an integrated approach to landscape management and restoring a well-balanced package of goods and services provided by the landscapes. This would reduce 1 285 630 tCO2eq of GHG emissions by 2038 and restore 5 000 ha of degraded forests and landscapes. The project also supports intersectoral coordination and relevant policy harmonization to address climate change and conserve biodiversity, including support to the NDC enhancement processes.

Notes: For more information on the "Paris Agreement in action" project, see www.fao.org/in-action/boosting-transparency-forest-data/en/.

For Morocco's revised NDC: Ministère de l'énergie, des mines et de l'environnement du Royaume du Maroc. 2021. Contribution déterminée au niveau national – actualisée. Rabat. https://unfccc.int/sites/default/files/NDC/2022-06/Moroccan%20updated%20NDC%202021%20_Fr.pdf emissions (Noon *et al.*, 2021). Better targeting of FLR initiatives that support opportunities to conserve landscapes with "irrecoverable carbon" can therefore increase global climate security and mitigation objectives.

Forest and landscape restoration, and climate action can both benefit from addressing the drivers of degradation and deforestation. Key drivers such as agricultural expansion, unsustainable production and resource extraction, limited livelihood opportunities, adverse policies and incentives, inappropriate land management and the impacts of climate change itself must be understood in local economic, social, political and environmental contexts to enable appropriate restoration responses.

6. Recommendations for action

Continued degradation and deforestation are undermining efforts to make development gains. They are also fuelling continued GHG emissions, impacting the cost and ability to reach national and global climate commitments (UNEP, 2021a). The impacts of climate change itself also undermine restoration efforts, affecting long-term outcomes and imposing stress on ecosystems and those communities dependent on them (Timpane-Padgham, Beechie and Klinger, 2017). The FLR approach has been promoted as a cost-effective and inclusive solution to not only restore and reverse degraded and deforested landscapes, but also to conserve and support biodiversity, enable sustainable livelihoods, and mitigate and adapt to the impacts of climate change. To achieve the 1.5 °C or 2.0 °C temperature targets, FLR has the potential to contribute to wider international global goals such the Paris Agreement and the SDGs (Temperton *et al.*, 2019).

This paper has illustrated the clear links between the FLR and climate change mitigation and adaptation agendas. It has shown how existing restoration projects, financed by mechanisms such as the GEF, GCF and AF are already implementing restoration with clear climate change mitigation and adaptation outcomes. Restoration of ecological functionality, together with protection and conservation, will have significant impact on mitigating further GHG emissions and boosting carbon sequestration. From agroforestry, ANR, SFM, development of sustainable value chains and alternative energy sources, FLR offers a wide range of interventions to build environmental and socioeconomic resilience to support adaptation to climate change. These are already being integrated in national climate commitments and plans.

Opportunities

The paper has also highlighted the challenges to enabling further integration of restoration and climate change mitigation and adaptation agendas. To address the main challenges, understanding the direct and indirect drivers for degradation and deforestation, and their links with fuelling climate change further is key. Unless these are identified and fully understood in context – the most appropriate and applicable restoration approach, which can also achieve high climate change mitigation and adaptation impact – the long-term success of initiatives may be undermined.

Innovative investment is required to support restoration initiatives that have multiple cobenefits, including supporting climate change adaptation and mitigation. A better integration of restoration-aligned opportunities and projects within climate finance such as the AF and GCF can better link funds and mobilize forest-based climate change mitigation and adaptation finance. To scale up restoration initiatives and impact, FLR requires diverse funding mechanisms, in particular those from the private sector. Building on financial pledges made at COP26, further engagement of donors, the opportunity of green deals (European Union, United States of America) and the potential of other financial mechanisms originating from the private sector such as equity funds, citizen money, restoration offsets or other restoration efforts from companies (e.g. environment, social and governance criteria), are needed, especially in the long term to very long term. Further incentives to finance restoration linked to climate change should also be explored, building on the growth in the voluntary carbon market and expected additional demand for forest carbon credits for compliance purposes through, for example, CORSIA, LEAF and TREES, supported by the Glasgow Climate Pact and Article 6.

The potential to strengthen direct links between restoration agendas such as FLR and carbon sequestration should also be explored further. This can be supported by the development of a sustainable monitoring system (for GHG measurement, reporting and verification) linked to restoration activities to identify key conditions for prioritizing restoration in landscapes with the highest climate change mitigation and adaptation impact (e.g. for biomes such as mangroves and peatlands, and for disaster risk reduction for socioeconomic benefits). Further integration and enhancement of the role of restoration in meeting national climate commitments (e.g. NDCs, NAPs and NAPAs) can also enable the mainstreaming of quantitative restoration commitments to foster synergies and improved coordination across intersectoral plans and policies, through for example, the integration of peatland restoration and conservation into NDCs and development of restoration-aligned national targets. Increased integration of quantitative conditional restoration-aligned targets and measures in NDCs would also reinforce NDC achievement and scale up restoration and climate change mitigation and adaptation impacts.

The implementation of key FLR approaches that support the climate change agenda requires strong engagement and participation from all stakeholders, including Indigenous Peoples throughout the restoration process. A recognition of their role as key stakeholders and land stewards, including ensuring an equitable share of benefits from the implementation of restoration initiatives, has been made by the CBD and COP26. This should be incorporated into future restoration projects, and initiatives led by Indigenous Peoples should be prioritized for investment. This requires consideration of land tenure security, which presents a key challenge for implementation of results-based payments such as REDD+. Forest and landscape restoration initiatives should therefore recognize the knowledge and customary rights of Indigenous Peoples through free, prior and informed consent, to enable participatory engagement, improved equity of benefit sharing and work with the national policy support needed to strengthen territorial rights and governance.

The FLR process enables a long-term vision to facilitate the restoration of ecosystem functionality and resilience. This is key to addressing many of the long-term impacts of climate change. It includes the gradual transition towards the protection and conservation of carbon in the ground, together with more sustainable livelihoods and sources of energy. There is clear potential in ensuring the development of key value chains and more efficient wood energy supply chains (as well as the adoption of alternative forms of energy) in restoration approaches that can also mitigate climate change and enable greater socioeconomic and environmental resilience for those reliant on natural resources.

Forests play a fundamental role in addressing climate change. Urgent action to combat deforestation and land degradation is needed to meet ambitious global restoration and climate goals, including efforts to reduce GHG emissions as close as possible to zero, as well as to restore and preserve biodiversity. Outcomes from COP26 and the launch of the United Nations Decade on Ecosystem Restoration in 2021 present a clear opportunity to build on this momentum to better link restoration to the climate agenda. The integrated approach of FLR has the potential to support diverse and cost-effective outcomes to deliver both mitigation and adaptation objectives both within FAO (FAO 2021a) and with country and project partners. This paper has highlighted the huge potential for FLR to strengthen, accelerate and scale up local-level and national capacity for climate action. Building on the momentum from COP26 and the United Nations Decade on Ecosystem Restoration (2021–2030), there is significant potential to promote FLR as a key solution for meeting the goals of the Paris Agreement as well as incorporating climate mitigation and adaptation objectives within wider restoration initiatives.

14 August 2010, Shangla - A panoramic view of a river valley.

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7. References

ADB (Asian Development Bank). 2014. Climate risk management in ADB projects. Manila. www.adb.org/sites/default/files/publication/148796/climate-risk-management-adb-projects.pdf

African Development Bank. 2020. Guidelines on the Development of an Adaptation Benefits Mechanism methodology. www.afdb.org/sites/default/files/2020/09/15/20200903_guidelines_on_abm_methodologies_abm_ec_2020-5-10.pdf

Appanah, S., Shono, K. & Durst, P.B. 2015. Restoration of forests and degraded lands in Southeast Asia. Unasylva No. 245, Vol. 66 2015/3.

Bastin, J-F., Finegold, Y., Garcia, C., Mollicone, D., Rezende, M., Routh, D., Zohner, C.M. & Crowther, T.W. 2019. The global tree restoration potential. Science, 365(6448): 76–79.

Beatty, C.R., Cox, N. A. & Kuzee, M.E. 2018. Biodiversity guidelines for forest landscape restoration opportunities assessments. First edition. Gland, Switzerland, IUCN.

Begeladze, S. 2019. Bonn Challenge and Forest and Landscape Restoration: Understanding synergies and identifying opportunities across Rio Conventions. Gland, Switzerland, IUCN. https://unece.org/fileadmin/DAM/timber/meetings/2019/20191216/2019-10-belgrade-rioconv-begeladze.pdf

Bernal, B., Murray, L.T. & Pearson, T.R.H. 2018. Global carbon dioxide removal rates from forest and landscape restoration activities. Carbon Balance and Management, 13:22. https://infoflr.org/sites/default/files/2019-04/global_carbon_dioxide_removal_rates_0.pdf

Besacier, C., Garrett, L., Iweins, M. & Shames, S. 2021. Local financing mechanisms for forest and landscape restoration – A review of local level investment mechanisms. Forestry Working Paper No. 21. Rome. FAO. https://doi.org/10.4060/cb3760en

Blomley, T. 2013. Lessons learned from community forestry in Africa and their relevance for REDD+. Forest Carbon, Markets and Communities (FCMC) Program. USAID, Washington, D.C. www.climatelinks.org/sites/default/files/asset/document/CF_Africa.pdf

Bonn Challenge. 2022. Bonn Challenge: Restore our future. Cited 3 August 2022. www.bonnchallenge.org

Booth, W. 2021. Serious about climate change? Get serious about peat. Washington Post, 10 November 2021. Cited August 2022. www.washingtonpost.com/world/2021/11/10/cop26-peat-carbon

Bos, A.B., De Sy, V., Duchelle, A.E., Atmadja, S., de Bruin, S., Wunder, S. & Herold, M. 2020. Integrated assessment of deforestation drivers and their alignment with subnational climate change mitigation efforts. Environmental Science and Policy, 114, 352–365.

Bradley, A. & Fortuna, S. 2021. Collective tenure rights for REDD+ implementation and sustainable development. Rome, FAO.

Brancalion, P.H.S. & Chazdon, R.L. 2017. Beyond hectares: four principles to guide reforestation in the context of tropical forest and landscape restoration. Restoration Ecology, 25(4).

Busch, J., Englemann, J., Cook-Patton, S.C., Griscom, B.W., Koeger, T., Possingham, H. & Shyamsundar, P. 2019. Potential for low-cost carbon dioxide removal through tropical reforestation. Nature Climate Change, 9, 463–466.

Cannon, J. 2021. Layers of carbon: The Congo Basin peatlands and oil. Mongabay, 7 December 2021. https://news.mongabay.com/2021/12/layers-of-carbon-the-congo-basin-peatlands-and-oil

Chagas, T., Galt, H., Lee, D., Neeff, T. and Streck, C. 2020. A close look at the quality of REDD+ carbon credits. Climate Focus. https://climatefocus.com/publications/close-look-quality-redd-carbon-credits

Chazdon R.L., Wilson, S.J., Brondizio, E., Guariguata, M.R. & Herbohn, J. 2021. Key challenges for governing forest and landscape restoration across different contexts. Land Use Policy, 104. https://doi.org/10.1016/j.landusepol.2020.104854

Christin, Z.L., Bagstad, K.J. & Verdone, M.A. 2016. A decision framework for identifying models to estimate forest ecosystem services gains from restoration. Forest Ecosystems, 3:3.

Ciccarese, L. 2012. Ecosystem services from forest restoration: Thinking ahead. New Forests, 43, 543–560.

Colloff, M.J., Martín-López, B., Lavorel, S., Locatelli, B, Gorddard, R., Longaretti, P-Y., Walters, G., van kerkhodd, L., Wyborn, C., Coreau, A., Wise, R.M., Dunlop, M., Degeorges, M.D., Capon, T., Sanderson, T. & Murphy, H.T. 2017. An integrative framework for enabling transformative adaptation. Environmental Science & Policy, 68: 87–96.

Colomb, V., Touchemoulin, O., Bockel, L., Chotte, J.L., Martin, S., Tinlot, M. & Bernoux, M. 2013. Selection of appropriate calculators for landscape-scale greenhouse gas assessment for agriculture and forestry. Environmental Research Letters, 8, 015029.

Cook-Patton, S.C., Drever, C.R., Griscom, B.W., Hamrick, K., Hardman, H., Kroeger, T., Pacheco, P., Raghav, S., Stevenson, M., Webb, C., Yeo, S. & Ellis, P.W. 2021. Protect, manage and then restore lands for climate change. Nature Climate Change, 11, 1027–1034.

Crouzeilles , R., Curran, M., Ferreira, M.S., Lindenmayer, D.B., Grelle, C.E.V. & Rey Benayas, J.M. 2016. A global meta-analysis on the ecological drivers of forest restoration success. Nature Communications, 7, 11666. www.nature.com/articles/ncomms11666

Crumpler, K., Abi Khalil, R., Tanganelli, E., Rai, N., Roffredi, L., Meybeck, A., Umulisa, V., Wolf, J. & Bernoux, M. 2021. (Interim) Global update report – Agriculture, Forestry and Fisheries in the Nationally Determined Contributions. Environment and Natural Resources Management Working Paper No. 91. Rome, FAO. https://doi.org/10.4060/cb7442en

Crumpler, K., Bloise, M., Meybeck, A., Salvatore, M. & Bernoux, M. 2019. Linking Nationally Determined Contributions and the Sustainable Development Goals through Agriculture: A methodological framework. Environment and natural resources management working paper No. 75 Rome, FAO.

Dasgupta, P. 2021. The Economics of Biodiversity: The Dasgupta Review. London, HM Treasury.

De Jong, W., van der Zon, M., Urushina, A.F., Yeo-Chang, Y., Liu, J. & Li, N. 2018. Tenure, property rights and forest and landscape restoration. In: Forest Landscape Restoration: Integrated Approaches to Support Effective Implementation, pp 158–175. London, Taylor and Francis. www.taylorfrancis.com/books/e/9781315111872/chapters/10.4324/9781315111872-10

DFID (UK Department for International Development). 2003. DFID Environment Guide. A guide to environmental screening. London. https://europa.eu/capacity4dev/file/25415/download?token=aKBL-oUv

Ding, H., Faruqi, S., Wu, A., Altamirano, J-C., Ortega, A.A., Zamora-Cristales, R., Chazdon, R., Vergara, W. & Verdone, M. 2018. Roots of Prosperity: The Economics and Finance of Restoring Land. Washington, DC: World Resources Institute

Djoudi, H. & Brockhaus, M. 2011. Is adaptation to climate change gender neutral? Lessons from communities dependent on livestock and forests in northern Mali. International Forestry Review, 13(2):123–135. https://doi.org/10.1505/146554811797406606

European Union. 2021. Taxonomy Regulation: Approved EU Taxonomy Climate Delegated Act under Art. 10(3) and 11(3) of the Taxonomy Regulation. Paper for the scrutiny session of the joint meeting of ECON and ENVI. 21 May 2021. www.europarl.europa.eu/RegData/etudes/BRIE/2021/648248/IPOL_BRI(2021)648248_EN.pdf

Fagan, M.E., Reid, J.L., Holland, M.B., Drew, J.G. & Zahawi, R.A. 2020. How feasible are global forest commitments? Conservation Letters, 13(3). https://conbio.onlinelibrary.wiley.com/doi/10.1111/conl.12700

FAO. 2014. Towards climate-responsible peatlands management. Mitigation of Climate Change in Agriculture Series 9. Rome. www.fao.org/3/i4029e/i4029e.pdf

FAO. 2015. Forest and Landscape Restoration. Unasylva No. 245, Vol. 66, 2015/3.

FAO. 2019. Ex-Ante Carbon Balance Tool Ex-Act. Mainstreaming greenhouse house gas accounting into agricultural investments and policies. Rome. www.fao.org/3/ca7087en/CA7087EN.pdf

FAO. 2020a. Restoring the Earth – The next decade. Unasylva, No. 252, Vol. 71 2020/1. Rome

FAO. 2020b. Peatland mapping and monitoring: Recommendations and technical overview. Rome. https://doi.org/10.4060/ca8200en

FAO. 2020c. Boosting transparency of forest data. In: FAO. Cited August 2022. www.fao.org/in-action/boosting-transparency-forest-data/en

FAO. 2020d. State of the World's Forests: Forests, Biodiversity and People. Rome.

FAO. 2021a. The Director-General's Medium-Term Plan 2022–2025 and Programme of Work. www.fao.org/3/ne576en/ne576en.pdf

FAO. 2021b. Mainstreaming climate risk management into FAO programming. Rome. www.fao.org/3/cb2669en/cb2669en.pdf

FAO. 2022.The State of the World's Forests 2022. Forests pathways for green recovery and building inclusive, resilient and sustainable economies. Rome. https://doi.org/10.4060/cb9360en

FAO & FILAC (Fund for the Development of Indigenous Peoples of Latin America). 2021. Forest Governance by Indigenous and Tribal People. An Opportunity for Climate Action in Latin America and the Caribbean. Rome and La Paz. https://doi.org/10.4060/cb2953en

FAO & Global Mechanism of the UNCCD (United Nations Convention to Combat Desertification). 2015. Sustainable Financing for Forest and Landscape Restoration – Opportunities, challenges and the way forward. Discussion Paper. Rome.

FAO, IUCN CEM and SER. 2021. Principles for ecosystem restoration to guide the United Nations Decade 2021–2030. Rome. www.fao.org/documents/card/en/c/CB6591EN

FAO & WRI (World Resources Institute). 2019. The road to restoration: A guide to identifying priorities and indicators for monitoring forest and landscape restoration. Rome and Washington, DC. www.fao.org/3/ca6927en/CA6927EN.pdf

Favretto, N., Dougill, A.J., Stringer, L.C., Afionis, S. & Quinn, C., H. 2018. Links between climate change mitigation, adaptation and development in land policy and ecosystem restoration projects: Lessons from South Africa. Sustainability, 10(3):799. https://doi.org/10.3390/su10030779

Feng, Y., Zhenzhong, Z., Searchinger, T.D., Ziegler, A.D., Wu, J., Wang, D., He, X., Elsen, P.R., Philippe, Ca., Xu, R., Guo, S., Peng, L., Tao, Y., Spracklen, D.V., Holden, J., Liu, X., Zheng, Y., Xu, P., Chen, J., Jiang, X., Song, X-P., Lakshmi, V., Wood, E.F. & Zheng, C. 2022. Doubling of annual forest carbon loss over the tropics during the early twenty-first century. Nature Sustainability, 5, 444–451. https://doi.org/10.1038/s41893-022-00854-3

Forest Trends' Ecosystem Marketplace. 2021. 'Market in Motion', State of the Voluntary Carbon Markets 2021, Instalment 1. Washington DC: Forest Trends Association www.forest-trends.org/publications/state-of-the-voluntary-carbon-markets-2021

Friedlingstein P., Allen, M., Canadell, J.G., Peters, G.P. & Seneviratne, S.I. 2019. Comment on "The global tree restoration potential". Science, 366 (6463). www.science.org/doi/10.1126/science.aaz0388

GBEP (Global Bioenergy Partnership). 2020. Positive relationships between sustainable wood energy and forest landscape restoration. Working Group on Capacity Building. June 2020. Cited August 2022.

GCF (Green Climate Fund). 2020. SAP019: Gums for Adaptation and Mitigation in Sudan (GAMS): Enhancing adaptive capacity of local communities and restoring carbon sink potential of the Gum Arabic belt, expanding Africa's Great Green Wall. Funding proposal. www.greenclimate.fund/sites/default/files/document/sap019-fao-sudan.pdf

GEF (Global Environment Facility). 2019a. STAP Guidance on Climate Risk Screening. 56th GEF Council Meeting. June 11–13 2019, Washington, DC. www.thegef.org/sites/default/files/council-meeting-documents/EN_GEF.STAP_.C.56.Inf_.03_STAP%20guidance%20on%20climate%20risk%20screening.pdf

GEF. 2019b. Biodiversity conservation, restoration and integrated sustainable development of lower Mangoky and South-Mananara watersheds. Project document. https://publicpartnershipdata.azureedge.net/gef/GEFProjectVersions/c025b99a-c1e6-e911-a83a-000d3a375590_PIF.pdf

GEF. 2020. Landscape restoration for increase resilience in urban and peri-urban areas of Bujumbura. Project document. https://publicpartnershipdata.azureedge.net/gef/GEFProjectVersions/661cb0a3-52c8-e811-813a-3863bb3c4538_PIF.pdf

GEF. 2021a. Land Degradation. In: GEF. Cited August 2022. www.thegef.org/topics/land-degradation#:~:text=Globally%2C%203.2%20billion%20people%20are,feed%2C%20fiber%2C%20and%20fuel

GEF. 2021b. CSIDS-SOILCARE Phase1: Caribbean Small Island Developing States (SIDS) multicountry soil management initiative for Integrated Landscape Restoration and climate-resilient food systems. In : GEF. Cited August 2022. www.thegef.org/projects-operations/projects/10195

GEF. 2022. Forests. In: GEF. Cited August 2022. www.thegef.org/topics/forests

Goldstein, A., Turner, W.R., Spawn, S.A., Anderson-Teixeira, K.J., Cook-Patton, S., Fargione, J., Gibbs, H.K., Griscom, B., Hewson, J.H., Howard, J.F., Ledezma, J.C., Page, S., Koh, L.P., Rockström, J., Sanderman, J. & Hole, D.G. 2020. Protecting irrecoverable carbon in Earth's ecosystems. Nature Climate Change. 10, 287–295 https://doi.org/10.1038/s41558-020-0738-8

GPFLR (Global Partnership on Forest and Landscape Restoration). 2018. The Global Partnership on Forest and Landscape Restoration. Cited August 2022. www.forestlandscaperestoration.org

GPFLR. 2022. About us. Cited September 2022. www.forestlandscaperestoration.org/about-us

Griscom, B.W., Adams, J., Ellis, P.W. & Fargione, J. 2017. Natural climate solutions. PNAS, 114 (44): 11645–11650. www.pnas.org/doi/10.1073/pnas.1710465114

Joosten, H., Tapio-Biström, M.-L. & Tol, S., eds. 2012. Peatlands – guidance for climate change mitigation through conservation, rehabilitation and sustainable use. Second edition. Mitigation of Climate Change in Agriculture Series 5. Rome, FAO and Wetlands International.

Harris, N.L., Gibbs, D.A., Baccini, A., Birdsey, R.A., de Bruin, S., Farina, M., Fatoyinbo, L., Hansen, M.C., Herold, M., Houghton, R.A., Potapov, P.V., Suarez, D.R., Roman-Cuesta, R.M., Saatchi, S.S., Slay, C.M., Turubanova, S.A. & Tyukavina, A. 2021. Global maps of twenty-first century forest carbon fluxes. Nature Climate Change, 11:234–240. https://doi.org/10.1038/s41558-020-00976-6

Höhl M., Ahimbisibwe, V., Stanturf, J., Elsasser, P., Kleine, M. & Bolte, A. .2020. Forest Landscape Restoration—What Generates Failure and Success? Forests, 11(9) 938. https://doi.org/10.3390/f11090938

IKI (International Climate Initiative). 2021. The Paris Agreement in action: upscaling forest and landscape restoration to achieve nationally determined contributions. In: IKI. Berlin. Cited August 2022. www.international-climate-initiative.com/en/details/project/the-paris-agreement-in-action-upscaling-forest-and-landscape-restoration-to-achieve-nationally-determined-contributions-18_III_094-3037

IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio

E.S., H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. 56 pages. https://ipbes.net/sites/default/files/inline/files/ipbes_global_assessment_report_summary_for_policymakers.pdf

IPCC (Intergovernmental Panel on Climate Change). 2007. IPCC Fourth Assessment Report : Climate Change 2007. Working Group II : Impacts, Adaptation and Vulnerability. Definition of key terms. In: IPCC. Cited August 2022. https://archive.ipcc.ch/publications_and_data/ar4/wg2/en/frontmattersg.html

IPCC. 2019. Summary for Policymakers. In: P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D.C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi & J. Malley, eds. Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security and greenhouse gas fluxes in terrestrial ecosystems. In press. www.ipcc.ch/site/assets/uploads/sites/4/2020/02/SPM_Updated-Jan20.pdf

IPCC. 2021. Summary for Policymakers. In: V. Masson-Delmotte, P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu & B. Zhou, eds. Climate Change 2021: The physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the IPCC. Cambridge, UK and New York, Cambridge University Press. www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

IPCC. 2022a. Summary for Policymakers. In: H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem & B. Rama, eds. Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the IPCC. Cambridge, UK and New York, Cambridge University Press. https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

IPCC. 2022b. Summary for Policymakers. In: P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz & J. Malley, eds. Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the IPCC. Cambridge, UK and New York, USA, Cambridge University Press. www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SPM.pdf

IRP (International Resource Panel). 2019. Land Restoration for Achieving the Sustainable Development Goals: An International Resource Panel Think Piece. Herrick, J.E., Abrahamse, T., Abhilash, P.C., Ali, S.H., Alvarez-Torres, P., Barau, A.S., Branquinho, C., Chhatre, A., Chotte, J.L., Cowie, A.L., Davis, K.F., Edrisi, S.A., Fennessy, M.S., Fletcher, S., Flores-Díaz, A.C., Franco, I.B., Ganguli, A.C., Ifejika Speranza, C., Kamar, M.J., Kaudia, A.A., Kimiti, D.W., Luz, A.C., Matos, P., Metternicht, G., Neff, J., Nunes, A., Olaniyi, A.O., Pinho, P., Primmer, E., Quandt, A., Sarkar, P., Scherr, S.J., Singh, A., Sudoi, V., von Maltitz, G.P., Wertz, L., Zeleke, G. A think piece of the International Resource Panel. Nairobi, UNEP.

ITTO (International Tropical Timber Organization). 2022. Guidelines for forest landscape restoration in the tropics. Policy Brief. Yokohama, Japan.

IUCN (International Union for the Conservation of Nature). 2017. Gender-responsive restoration guidelines: A closer look at gender in the Restoration Opportunities Assessment Methodology. Gland, Switzerland: IUCN.

IUCN. 2019. Forest Landscape Restoration in the spotlight. Contributions of FLR to the implementation of the UN Strategic Plan for Forests and the thematic priorities of the SDGs under review at HLPF 2019. IUCN Submission for the UN Forum of Forests 14th session on good practices, success stories and lessons learned on forests. www.un.org/esa/forests/wp-content/uploads/2019/05/IUCN-good-practices.pdf

IUCN. 2020a. Benefits of FLR. In: INFOFLR by IUCN. Cited August 2022. https://infoflr.org/what-flr/benefits-flr

IUCN. 2021a. Forests and climate change. IUCN Issues Brief. February 2021. www.iucn.org/resources/issues-brief/forests-and-climate-change

IUCN. 2021b. IUCN World Conservation Congress, Marseille. The Marseille Manifesto, 10 September 2021. https://iucn.s3.eu-west-3.amazonaws.com/en/CGR-2021-1.6-2_Marseille_Manifesto_IUCN_World_Conservation_Congress_10_%20September_2021.pdf

IUCN. 2021c. Peatlands and climate change. IUCN Issues Brief. November 2021. Cited August 2022. www.iucn.org/sites/default/files/2022-04/iucn_issues_brief_peatlands_and_climate_change_final_nov21.pdf

IUCN & WRI. 2014. A guide to the Restoration Opportunities Assessment Methodology (ROAM): Assessing forest landscape restoration opportunities at the national or sub-national level. Working Paper. Gland, Switzerland and Washington, DC. 125pp. https://portals.iucn.org/library/sites/library/files/documents/2014-030.pdf

IUFRO (International Union of Forest Research Organizations). 2015. Forest Landscape Restoration as a Strategy for Mitigating and Adapting to Climate Change. Project flyer. Vienna.

Joosten, H. 2015. Peatlands, climate change mitigation and biodiversity conservation: An issue brief on the importance of peatlands for carbon and biodiversity conservation and the role of drained peatlands as greenhouse gas emission hotspots (Vol. 2015727). Nordic Council of Ministers. www.ramsar.org/sites/default/files/documents/library/ny_2._korrektur_anp_peatland.pdf

Joosten, H. & Couwendberg, J. 2009. Are emission reductions from peatlands MRV-able? Wetlands International. www.imcg.net/media/download_gallery/climate/joosten_couwenberg_2009.pdf

Lawrence, D., Coe, M., Walker, W., Verchot, L. & Vandecar, K. 2022. The unseen effects of deforestation: Biophysical effects on climate. Frontiers in Forests and Global Change, 24 March 2022. https://doi.org/10.3389/ffgc.2022.756115

Leifeld, J. & Menichetti, L. 2018. The underappreciated potential of peatlands in global climate change mitigation strategies. Nature Communications 9:1071. https://doi.org/10.1038/s41467-018-03406-6

Locatelli, B., Catterall, C. & Imbach P. 2015. Tropical reforestation and climate change: beyond carbon. Restoration Ecology, 23(4): 337–343. https://doi.org/10.1111/rec.12209

Löfgvist, A. & Ghazoul, J. 2019. Private funding is essential to leverage forest and landscape restoration at global scales. Nature Ecology & Evolution. 3, 1612–1615.

López Gonzales, M., Hergoualc'h, K., Angulo Núñez, Ó., Baker, T., Chimner, R., del Águila Pasquel, J., del Castillo Torres, D., Freitas Alvarado, L., Fuentealba Durand, B. & García Gonzales, E. **et al**. 2020. What do we know about Peruvian peatlands? Occasional Paper 210. Bogor, Indonesia, CIFOR.

Louman, B., Meybeck, A., Mulder, G., Brady, M., Fremy, L., Savenije, H., Gitz, V. & Trines, E. 2020. Innovative finance for sustainable landscapes. Working Paper 7. Bogor, Indonesia, CGIAR Research Program on Forests, Trees and Agroforestry. https://doi.org/10.17528/cifor/007852

Macqueen, D.J. 2021. Local climate resilience finance: how can mirage become reality? IIED, London. https://pubs.iied.org/20446iied

Mansourian, S., Dudley, B. & Vallauri, D. 2017. Forest landscape restoration: Progress in the Last decade and remaining challenges. Ecological Restoration Vol 35. No. 4, 281-288 DOI:10.3368/er.35.4.281

Mansourian, S. & Berrahmouni, N. 2021. Review of forest and landscape restoration in Africa. Accra. FAO and AUDA-NEPAD. https://doi.org/10.4060/cb6111en

Mansourian, S., Berrahmouni, N., Blaser, J., Dudley, N., Maginnis, S., Mumba, M. & Vallauri, D. 2021. Reflecting on Twenty years of Forest Landscape Restoration. Restoration Ecology, 29(7). https://doi.org/10.1111/rec.13441

McLain, R., Lawry, S., Guariguata, M.R. & Reed, J. 2021. Towards a tenure-responsive approach to forest landscape restoration: A proposed tenure diagnostic for assessing restoration opportunities. Land Use Policy, 104, 103748. https://doi.org/10.1016/j.landusepol.2018.11.053

McLain, R., Ranjatson, P., Lawry, S., Rakotonirina, J.M., Randrianasolo, R. & Razafimbelo, N.T. 2018. Tenure challenges to implementing forest landscape restoration in northwestern Madagascar. Info Brief. Bogor, Indonesia, CIFOR. https://doi.org/10.17528/cifor/007492

Meybeck, A., Gitz, V., Wolf, J. & Wong, T. 2020. Addressing forestry and agroforestry in National Adaptation Plans – Supplementary guidelines. Rome, FAO and Bogor, CGIAR Program on Forests, Trees and Agroforestry. https://doi.org/10.4060/cb1203en

Morice, C.P., Kenney, J.J., Rayner, N.A. & Jones, P.D. 2012. Quantifying uncertainties in global and regional temperature change using an ensemble of observational estimates: the HadCRUT4 dataset. Journal of Geophysical Research Atmospheres, 117 (D8). https://doi.org/10.1029/2011JD017187

Noon, M.L., Goldstein, A., Ledezma, J.C., Roehrdanz, P.R., Cook-Patton, S.C., Spawn-Lee, S.A., Maxwell Wright, T., Gonzalez-Roglich, M., Hole, D.G., Rockström, J. & Turner, W.R. 2021. Mapping the irrecoverable carbon in Earth's ecosystems. Nature Sustainability, 5, 37–46. https://doi.org/10.1038/s41893-021-00803-6

NYDF (New York Declaration on Forests). 2019. Goal 5 Assessment. Technical Annex to the Five-Year Assessment Report. https://forestdeclaration.org/wp-content/uploads/2020/11/2019NYDFGoal5.pdf

NYDF Assessment Partners. 2021. Taking stock of national climate action for forests. Goal 7 Progress Report. Climate Focus (coordinator and editor). www.forestdeclaration.org

Olsson, L., Barbosa, H., Bhadwal, S., Cowie, A., Delusca, K., Flores-Renteria, D., Hermans, K., Jobbagy, E., Kurz, W., Li, D., Sonwa, D.J. & Stringer, L. 2019. Land Degradation. In: P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi & J. Malley, eds. Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.. In press.

Pearson, T.R.H., Brown, S., Murray, L. & Sidman, G. 2017. Greenhouse gas emissions from tropical forest degradation: an underestimated source. Carbon Balance and Management, 12, 3. https://cbmjournal.biomedcentral.com/articles/10.1186/s13021-017-0072-2

Pörtner, H.O., Scholes, R.J., Agard, J., Archer, E., Arneth, A., Bai, X., Barnes, D., Burrows, M., Chan, L., Cheung, W.L., Diamond, S., Donatti, C., Duarte, C., Eisenhauer, N., Foden, W., Gasalla, M. A., Handa, C., Hickler, T., Hoegh-Guldberg, O., Ichii, K., Jacob, U., Insarov, G., Kiessling, W., Leadley, P., Leemans, R., Levin, L., Lim, M., Maharaj, S., Managi, S., Marquet, P. A., McElwee, P., Midgley, G., Oberdorff, T., Obura, D., Osman, E., Pandit, R., Pascual, U., Pires, A. P. F., Popp, A., Reyes-García, V., Sankaran, M., Settele, J., Shin, Y. J., Sintayehu, D. W., Smith, P., Steiner, N., Strassburg, B., Sukumar, R., Trisos, C., Val, A.L., Wu, J., Aldrian, E., Parmesan, C., Pichs-Madruga, R., Roberts, D.C., Rogers, A.D., Díaz, S., Fischer, M., Hashimoto, S., Lavorel, S., Wu, N. & Ngo, H.T. 2021. Scientific outcome of the IPBES-IPCC co-sponsored workshop on biodiversity and climate change. Bonn, Germany, IPBES Secretariat. doi10.5281/zenodo.4659158.

PROFOR. 2017. What do forests have to do with disaster risk management? Q&A with Annegien Tijssen. In: PROFOR. www.profor.info/notes/what-do-forests-have-do-disaster-risk-management-qa-annegien-tijssen

Rainforest Foundation Norway. 2021. Falling Short: Donor funding for Indigenous Peoples and local communities to secure tenure rights and manage forests in tropical countries 2011–2020. https://d5i6is0eze552.cloudfront.net/documents/Publikasjoner/Andre-rapporter/RFN_Falling_short_2021.pdf?mtime=20210412123104

Rietbergen-McCraken, J., Maginnis, S. & Sarre, A. 2007. The Forest Landscape Restoration Handbook. London, Earthscan. 175 pp.

Rights and Resources Initiative (RRI). 2018. A global baseline of carbon storage in collective lands. Indigenous and local community contributions to climate change mitigation. https://rightsandresources.org/wp-content/uploads/2018/09/A-Global-Baseline_RRI_Sept-2018.pdf

Rizvi, A.R., Baig, S., Barrow, E. & Kumar, C. 2015. Synergies between Climate Mitigation and Adaptation in Forest Landscape Restoration. Gland, Switzerland, IUCN. https://portals.iucn.org/library/efiles/documents/2015-013.pdf

Sabogal, C., Besacier, C. & MacGuire, D. 2015. Forest and landscape restoration: concepts, approaches and challenges for implementation. Unasylva. No. 245, Vol. 66, 2015/3.

Seddon, N., Smith, A., Smith, P., Key, I., Chausson, A., Girardin, C., House, J., Srivastava, S. & Turner, B. 2021. Getting the message right on nature-based solutions to climate change. Global Change Biology, 27(8), 15181546.

Shukla, P.R., Skea, J., Slade, R., van Diemen, R., Haughey, E., Malley, J., Pathak, M. & Portugal Pereira, J., eds. 2019. Technical Summary. In: P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M, Belkacemi & J. Malley, eds. Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. In press.

Slobodian, L., Vidal, A. & Saint-Laurent, C. 2020. Policies that support forest landscape restoration: What they look like and how they work. Gland, Switzerland: IUCN et al 2020. https://portals.iucn.org/library/sites/library/files/documents/2020-045-En.pdf

Stanturf, J.A., Kant, P., Lillesø, J-P. B., Mansourian, S., Kleine, M., Graudal, L. & Madsen, P. 2015. Forest landscape restoration as a key component of climate change mitigation and adaptation. IUFRO World Series, Vol. 34. Vienna, IUFRO.

Stanturf, J.A., Mansourian, S., Darabant, A., Kleine, M., Kant, P. & Burns, J. 2020. Forest landscape restoration implementation. Lessons learned from selected landscapes in Africa, Asia and Latin America. Vienna, IUFRO. www.iufro.org/uploads/media/op33.pdf

STAP (Scientific and Technical Advisory Panel). 2019. STAP Guidance on Climate Risk Screening. GEF and UNEP. www.stapgef.org/resources/advisory-documents/stap-guidance-climate-risk-screening

Sunderlin, W.D., de Sassi, C., Sills, E.O., Duchelle, A.E., Larson, A.M., Resosudarmo, I.A.P., Awono, A., Kweka, D.L. & Huynh, T.B. 2018. Creating an appropriate tenure foundation for REDD+: The record to date and prospects for the future. World Development 106, 376-392 https://doi.org/10.1016/j.worlddev.2018.01.010

Temmink, R.J.M., Lamers, L.P.M., Angelini, C., Bouma, T.J., Fritz, C., van de Koppel, K., Lexmond, R., Rietkerk, M., Silliman, B.R., Joosten, H. & van der Heide, T. 2022. Recovering wetland biogeomorphic feedbacks to restore the world's biotic carbon hotspots. Science Vol 376. Iss 6593 DOI: 10.1126/science.abn1479

Temperton, V.M., Buchmann, N., Buisson, E., Durigan, G., Kazmierczak, L., Perring, M.P., de Sá Dechoum, M., Veldman, J.W. & Overbeck, G.E. 2019. Step back from the forest and step up to the Bonn Challenge: how a broad ecological perspective can promote successful landscape restoration. Restoration Ecology, 27(4).

Timpane-Padgham, B.L., Beechie, T. & Klinger, T. 2017. A systematic review of ecological attributes that confer resilience to climate change in environmental restoration. PLoS ONE 12(3): e0173812. https://doi.org/10.1371/journal.pone.0173812

Toudert, A., Braimoh, A., Bernoux, M., St-Louis M., Abdelmagied, M., Bockel, L., Ignaciuk, A. & Zhao, Y. 2018. Carbon accounting tools for sustainable land management. Washington, DC, World Bank.

UNEP (United Nations Environment Programme). 2021a. Becoming #GenerationRestoration: Ecosystem restoration for people, nature and climate. Nairobi. https://wedocs.unep.org/bitstream/handle/20.500.11822/36251/ERPNC.pdf

UNEP. 2021b. Good news for Africa's Great Green Wall. In: UNEP. 13 January 2021 story. www.unep.org/news-and-stories/story/good-news-africas-great-green-wall

UNFCCC (United Nations Framework Convention on Climate Change). 2021. Nationally determined contributions under the Paris Agreement: Synthesis Report by the secretariat. https://unfccc.int/sites/default/files/resource/cma2021_08_adv_1.pdf

UNFCCC. 2022. Moving toward the Enhanced Transparency Framework. In: UNFCCC. Cited August 2022. https://unfccc.int/enhanced-transparency-framework

Veit, P.G. 2021. 9 Facts about community land and climate change. WRI. https://files.wri.org/d8/s3fs-public/2021-10/9-facts-about-community-land-and-climate-mitigation.pdf

Webb, N.P., Marshall, N.A., Stringer, L.C., Reed, M.A., Chappell, A. & Herrick, J.E. 2017. Land degradation and climate change: building climate resilience in agriculture. Frontiers in Ecology and the Environment, 5(8): 450–459. https://doi.org/10.1002/fee.1530

Winrock International and IUCN. 2018. Global FLR CO2 Removals Database. In: InfoFLR by IUCN. Cited August 2022. https://infoflr.org/what-flr/global-emissions-and-removals-databases#:~:text=The%20Global%20FLR%20CO2%20Removals,%2C%20fruit%20production%2C%20etc.)

WMO (World Meteorological Organization). 2013. WMO Risk Management Framework. WMO-No. 1111. Geneva. https://library.wmo.int/doc_num.php?explnum_id=7816

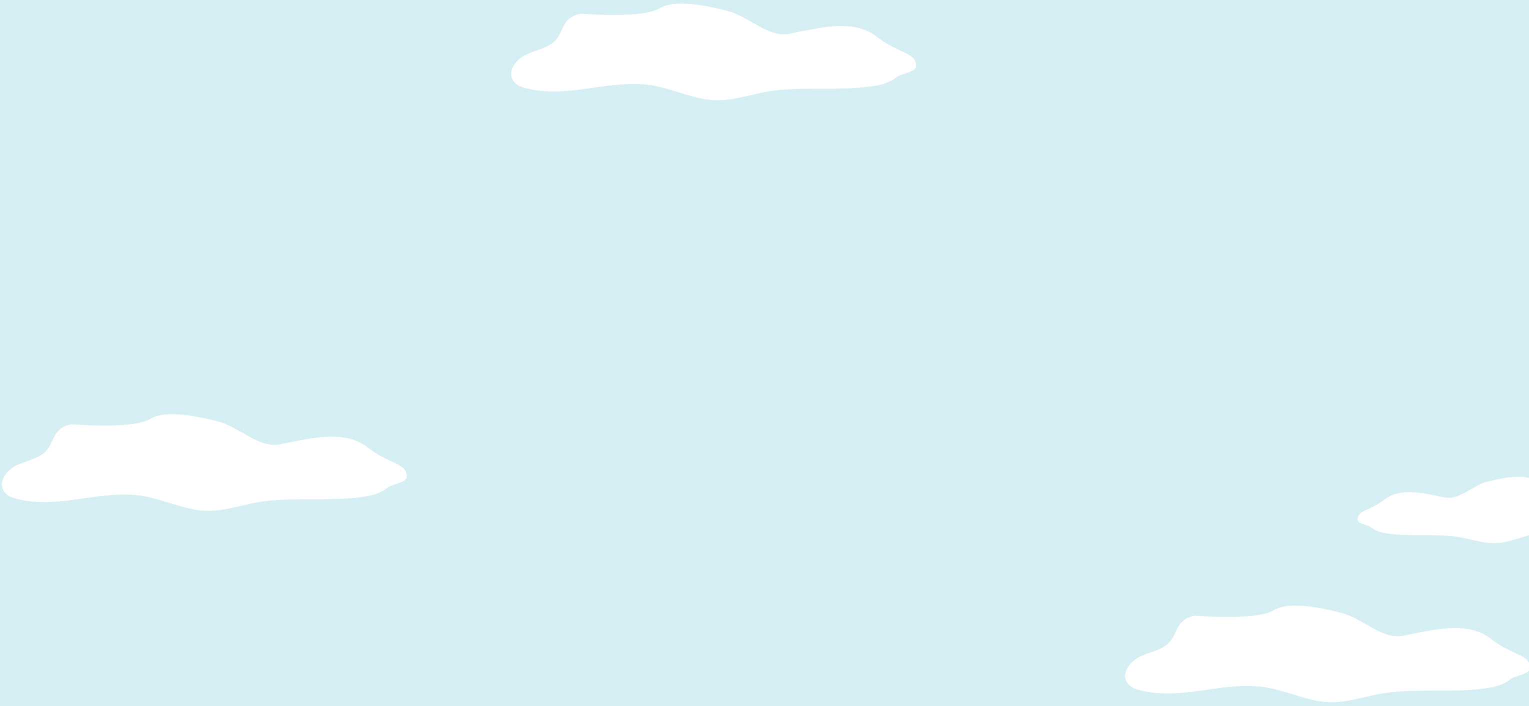
Wolff, S., Schrammeijer, E.A., Schulp, C.J.E., Verburg, P.H. 2018. Meeting global land restoration and protection targets: What would the world look like in 2050? Global Environmental Change, 52, 259–272. https://doi.org/10.1016/j.gloenvcha.2018.08.002

WRI (World Resources Institute). 2018. Aligning ambitions: The case for including restoration targets in climate goals. Text by A.,Wu & C., Gagné, 5 September 2018. In: WRI. Cited August 2022. www.wri.org/insights/aligning-ambitions-case-including-restoration-targets-climate-goals

WRI. 2022. Atlas of Forest and Landscape Restoration Opportunities. In: WRI. Cited August 2022. www.wri.org/resources/maps/atlas-forest-and-landscape-restoration-opportunities

WWF (World Wide Fund for Nature). 2020. Living planet Report 2020. Bending the curve of biodiversity loss. Almond, R.E:A., Grooten M. & Petersen, T., eds. Gland, Switzerland.

Yang, B. & He, J. 2021. Global land grabbing: A critical review of case studies across the world. Land, 10(3), 324. https://doi.org/10.3390/land10030324



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